

627
Utl

Inception, Organization, Proceedings of the Utah Irrigation and Drainage Congress

For the Years
1917-1920

UNIVERSITY OF ILLINOIS LIBRARY

JUN 3 1921



OBJECT:

**To Promote Profitable, Permanent Agriculture Through
Economical Use of Irrigation Water and
Consistent Drainage**

**MATHONIAH THOMAS,
JOHN A. WIDTSOE and
E. G. PETERSON, Presidents**

**ORSON W. ISRAELSEN
Secretary-Treasurer**

627
Utli

UNIVERSITY OF ILLINOIS LIBRARY

JUN 3 1924

Install an Electric Pump

Electric pumps will pull your water from any available source. It will drain your ditches, elevate your wellwater, pump from pond, lake, slough, river—and give you sufficient irrigation water for your farm.

Hundreds of Intermountain farmers are already enjoying the service of electric pumps—and profiting thereby. No need to worry about drouth or water rights. Just turn the switch of an electric pump—and you have water in abundance.

Let our experts advise you
as to the most effective
size and style for your
particular needs.

Utah Power & Light Co.

“Efficient Public Service”



Here is the "Jack of all Excavators"

**THE PAWLING
AND HARNISCHFEGER EXCAVATOR
CRANE**

As shown above it is at work excavating a canal for the
Union Land and Cattle Company at Reno, Nevada.

Let this machine construct and
maintain your canals. Think of
doing this work at five cents a yard.

Write us for complete specifications and Literature.

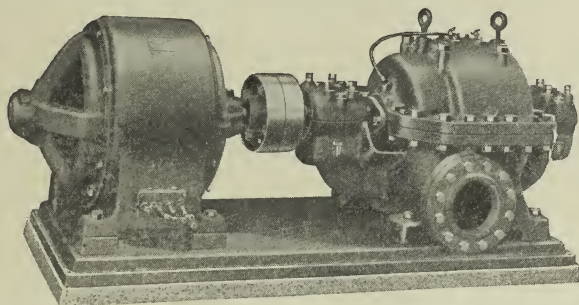
Landes & Company

2nd West and South
Temple

Salt Lake City
Utah

GOULD'S POWER PUMPS

FOR EVERY PURPOSE



WE INSTALL PLANTS COMPLETE

GALIGHER MACHINERY CO
101 WEST 2ND SOUTH (DOOLY BLOCK) SALT LAKE CITY

IRRIGATION and DRAINAGE

FOR SURFACE AND DRAINAGE SERVICE

USE DE LAVAL CENTRIFUGAL PUMPS

FOR DEEP WELL PUMPING SERVICE USE

LAYNE & BOWLER TURBINE PUMPS

Western Diesel Engines using fuel oil 13° to 20° Baume Gravity use less than one-half pint per horse power hour.

Sold exclusively in this territory by

The Salt Lake Hardware Company

Salt Lake City, Utah

Announcement

We shall be pleased to send to members of the Utah Irrigation and Drainage Congress descriptive literature on Drainage and Trench Excavators. Write.

Pawling & Harnischfeger Co.

Milwaukee, Wisconsin

Builders of P. & H. Excavators, Backfillers,
Tampers.

UTAH SALES COMPANY

515 Eccles Building
Ogden, Utah

907 Kearns Building
Salt Lake City, Utah

Agents for

**“OGDEN” and “RED DEVIL” Cement
Concrete for Permanent Waterways**

DO YOU KNOW

THAT the use of wood pipe antedates that of practically every other form of pipe, being used more than two centuries ago in London and at a much earlier period in some other European cities.

THAT one of the original London companies—an extensive user of wood pipe—organized to supply that city with water, is still operating; and that some of the wood pipe laid during the reign of Queen Anne, when recently replaced with larger mains was found to be in a state of perfect preservation.

THAT citizens of Fayetteville, N. C., are receiving water through wood pipe that was laid in 1829—the pipe still being sound

THAT modern wood pipe, size for size, will carry a greater volume of water than any other pipe made

THAT wood pipe is the only pipe whose capacity does not decrease with age

THAT many of the foremost cities of the world are receiving their supply of pure water through wood pipe

THAT wood pipe is today carrying the water which makes hundreds of thousands of acres of once desert land bloom like a veritable garden

THAT wood pipe is most easily adapted to difficult installations

THAT wood pipe is the most economical pipe to install and maintain and is the most efficient in service

THAT the present big users of wood pipe are the best prospects for future sales when further installations are required

THAT there is only one strip of land in the world on which the Redwood and Douglas Fir grows that provides material for the perfect staves of which correctly made wood pipe is formed—the Pacific Slope from Northern Washington on down through California

THAT we have engineers widely experienced in hydraulic problems who will frankly and honestly consult with you regarding the advisability of wood pipe for any project or installation

THAT you are not asked to buy wood pipe unless it is absolutely the best pipe for your purpose regardless of how much you want to invest; and further that if you buy it you will be instructed as to its proper use so that the fullest measure of utility may be obtained from it

THAT when we tell you wood pipe is the pipe for you to use there are thirty years of experience and an enviable record behind our statement

THAT full information—booklets—reliable data and suggestions of experts may be obtained by you for the asking?

(Tell us your problems)

WESTERN WOOD PIPE PUBLICITY BUREAU

White Building, Seattle, U. S. A.

Address all inquiries for details and prices to the following:

Continental Pipe Mfg. Company, Seattle

American Wood Pipe Company, Tacoma

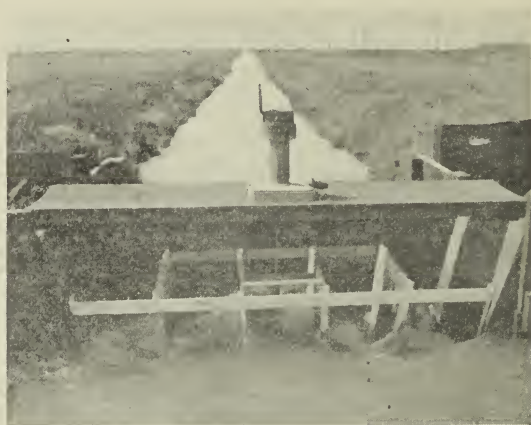
Pacific Tank and Pipe Company, San Francisco

Redwood — Douglas Fir

WOOD PIPE

CONTINUOUS STAVE—WIRE WOUND—BORED

Reliance Irrigation Meters



Size F 5—16 Sec. Ft. Meter installed for
Sacramento Valley West Side Canal
Company, Willows, Calif.

Water measurement as well as the making of a continuous record of flow in canals and laterals, has never been of greater importance than at the present time. **RELIANCE IRRIGATION METERS** are fast replacing old type weirs and other unsatisfactory measuring devices.

This meter has been fully proven as an accurate measuring and recording device, eliminating guesswork and approximation, insuring a square deal to the water company as well as the consumer.

There is a **RELIANCE METER** to fit your requirements insuring accurate measurements from 1-5 second foot up, easy to read, easy to install, and low in price.

Write us for full information and state your requirements or our agents will call and show you the meters.

RANDALL CONTROL AND HYDROMETRIC CORPORATION

805 Merchants National Bank Bldg.

Los Angeles, Cal.

WADE - WILLIAMS ENGINEERING COMPANY

601 Judge Bldg.

AGENTS

Salt Lake City

"H-A-R-D-E-S-T-Y"
on
IRRIGATION SUPPLIES
equals

"KARAT" ON GOLD--"STERLING" ON SILVER

BECAUSE every Hardesty product lives up to specifications and bears the mark that guarantees your protection.



Above cut shows combined county Bridge and Hardesty Flume across Big Horn River in Wyoming.

Every gate, every culvert, every flume made in The R. Hardesty Plant is built for practical use. The construction is simple, strong, durable and dependable.

Let your problems be ours. Write for our Irrigation Supply Catalog No. 11.

The R. Hardesty Manufacturing Co.

Woods Cross, Utah

Denver, Colo.

Missoula, Mont.

Pocatello, Idaho

**HAVE YOU KEPT YOUR SELF IN-
FORMED REGARDING THE PROPER,
PERMANENT AND ECONOMICAL
METHOD OF DITCH BUILDING**



If Not Write for Bulletin 130 to

Cement Gun Company, Inc.

ALLENTOWN, PA.

Inception of The Utah Irrigation and Drainage Congress

During the late summer of 1916 members of the Agricultural College began to work on the idea of an irrigation congress. Inquiries in various sections of the state as to the advisability of organizing the irrigation and drainage interests resulted in the calling of meetings at Logan in January, 1917, when a permanent organization was effected.

PURPOSE AND POLICIES OF THE CONGRESS

PURPOSE

Development.—The purpose of the Irrigation and Drainage Congress is to stimulate, and assist in consistent development of irrigation and drainage interests in Utah. Many conditions existing in the State tend to prevent desirable growth of our agriculture. A noteworthy example is the present chaotic condition of water rights in the older irrigation sections. Devising means of fairly and equitably determining and protecting vested water rights where irrigation has been practiced for many years is, however, no simple question. The problem is very perplexing.

Investigation.—The satisfactory solution of present day irrigation and drainage problems, in order to be lasting, must be based on careful and painstaking investigation and analysis of present conditions. The need of such study in Utah is beyond question and undoubtedly, an organization consisting of all the irrigation and drainage companies of Utah; individuals in the various professions interested in these subjects; and commercial, manufacturing, and construction companies may become a powerful factor in stimulating and conducting such investigations. That continuous and profitable development must be based on thorough knowledge, is fully recognized by all who have thought seriously along these lines.

Education.—Knowledge of irrigation and drainage, to be of real value, must be widely disseminated. Investigation without education would leave the desired goal unattained. There is also urgent need of wider dissemination of information now at hand. If the irrigation lawyer understood better the work of the engineer and farmer; if the farmer knew more of the real workings of law and engineering; and if engineers had greater sympathy toward the irrigators' problems, Utah's irrigation and drainage interests would fare very much better. The states of Oregon, Washington, Nebraska, Idaho and Kansas have recognized these facts and have, therefore, organized irrigation and drainage associations which have done much to advance agricultural prosperity. That adequate organization of Utah's irrigation and drainage interests will contribute much to her progress cannot be doubted.

POLICIES

An Open Forum.—The Utah Congress is open to all interested in its work. Engineers, lawyers, farmers, irrigation and drainage companies, construction and supply companies are especially invited to become members.

Types of Membership.—There are three types of membership. For annual membership a fee of \$1.00 is charged. An initial fee of \$15.00 entitles either individuals or companies to life membership. Honorary memberships may be conferred by a majority vote of the Board of Directors.

Equality of Opportunity.—The Congress aims to give every person, corporation, and profession equal opportunity to present problems and needs. No advantage shall be given to special factions.

Value to Members.—Consistent, honest publicity is valuable alike to engineer, lawyer, irrigator; and to construction, supply and development companies. The Congress will furnish this through its meetings and publications. Also the association with fellow workers has a stimulating effect of exceptional value. Moreover, the educational value which cannot be overestimated must be kept in mind.

The published reports of the Congress will become valuable records of the best irrigation thought as the years come and go; and also serve as a medium through which to become acquainted with methods, materials and men of value to irrigation and drainage.

OPENING MEETING

The first meeting of the Utah Irrigation and Drainage Congress was called to order at 9:30 a. m. January 31, 1917, at the Utah Agricultural College. Prof. O. W. Israelsen, who did much toward the initiation of the Congress movement, acted as temporary chairman. Prof. Israelsen outlined the needs for the organization of an Irrigation and Drainage Congress and advantages of having such an organization.

Mr. I. H. Jacob, Engineer for the Utah Lake Irrigation Company, presented the first paper of the regular program, his subject being the "Duties, Qualifications, and Efficiency of Canal Riders as Determining Factors in Successful Irrigation." Mr. Jacob's paper was clearly presented and was followed by an interesting discussion of the topic treated. Among other things, Mr. Jacob maintained that canal riders should be employed during the entire year and that their time could easily be used in computing data during the winter months. He further recommended that graduates of engineering colleges during the first few years of their professional practice be employed as canal riders. He called attention to one disadvantage in using engineering graduates; namely, that frequent changes in organization are then necessary as the engineer is not satisfied to

remain in the position of canal rider during a very long period of time.

Attorney J. Alex Melville, of Delta, talked concerning the "Doctrines of Riparian Rights and Prior Appropriation"; outlining fully the history of the two doctrines and showing the limitation of the former and the applicability of the latter to conditions in the western states. An interesting discussion followed Mr. Melville's talk, after which the meeting was adjourned to a general session in the College Assembly Room.

In the general assembly, Governor Ammons of Colorado, clearly showed the advantage of early development of irrigation resources and called attention especially to the fact that unless Utah and Colorado early use the head waters of the Colorado that prior appropriations by neighboring lower states may prevent our using such waters at a later date. "Indeed," said Governor Ammons, "our foreign neighbors on the South, the Mexicans, may use these waters unless we awaken to our opportunities in this connection."

Attorney Mathonihah Thomas, addressed the Congress and pointed out the inadequacy of Utah's present system of determining water rights and urged his hearer to organize a permanent body with a view to contributing to the solution of irrigation and drainage questions.

The Chair, after the close of Mr. Thomas' address, presented the question of the advisability of organizing a permanent irrigation and drainage congress and upon motion of Mr. R. A. Hart, it was unanimously decided to organize such a body. Upon motion of Mathonihah Thomas, the Chair appointed an organization committee of nine members as follows:

Mathonihah Thomas, chairman; R. A. Hart, L. M. Winsor, C. F. Brown, J. C. Wheelon, David McKay, N. P. Peterson, A. F. Cardon and Alex Melville.

The meeting was thereupon adjourned until two o'clock p. m.

AFTERNOON MEETING

Upon reassembling at two o'clock Mr. Egbert and Mr. Kirkham of the Utah Agricultural College Music Department entertained the Congress with vocal solos, after which the chair announced that the afternoon program would consist of two talks; one on the "Determination of Water Rights," by Mathonihah Thomas; and the other upon the "Possible Profits from the Drainage of Water-Logged Lands in Utah," by Mr. J. C.

Wheelon. Mr. Thomas spoke first and very forcefully described the present chaotic condition of Water Rights in Utah and urged emphatically that the irrigators of the State consider very carefully the desirability of making a thorough and speedy determination of Vested Water Rights. The pioneers established three things in regard to the water resources: 1, State ownership; 2, State control; 3, Beneficial and Economical use. It was shown by the speaker that an individual water user does not own the water, but owns only a right to the use thereof subject to the limitation imposed by the State. Mr. Thomas pointed out the need for soil surveys and duty of water studies.

Mr. Wheelon thereupon presented an excellent paper on "Possible Profits from the Drainage of Water-Logged Lands in Utah." He pointed out that in Illinois the value of land had been raised from \$25 to \$60 an acre and in Indiana from \$30 to \$75 an acre by the construction of a tile drainage system. He concluded by stating that there are 200,000 acres of land in Utah waiting to be drained at a profit of \$50 an acre or \$10,000,000.

Following Mr. Wheelon, Mr. Mathonihah Thomas presented the following report from the organization committee which was unanimously approved:

REPORT OF THE COMMITTEE ON ORGANIZATION

by Mathonihah Thomas, Chairman,

"Mr. Chairman, Gentlemen:

Your committee recommends:

1. That we here organize on a permanent basis, the Utah Irrigation and Drainage Congress.

2. That the purpose of organizing the Utah Irrigation and Drainage Congress be declared to be:

To further the interests of the State of Utah in the conservation of its water and to advance the interests of the State and its inhabitants in perfecting and protecting all irrigation and drainage interests.

3. That headquarters of the Congress shall be in Salt Lake City, and an annual convention shall be held at a point to be decided upon from year to year.

4. That articles of incorporation and by-laws be drawn up.

5. That the officers of the congress consists of:

A president; first, second and third vice-presidents; a secretary and a treasurer; which together with one director from

each of the seven judicial districts of the State, and one from each congressional district, and two from the state at large, shall constitute the Governing Board of the Congress.

6. That officers for the first year shall be:

Name	Address	Office
Mathonihah Thomas	Salt Lake City, Utah	President
W. D. Beers	Salt Lake City, Utah	First Vice-President
John C. Wheelon	Garland, Utah	Second Vice-President
A. F. Cardon	Logan, Utah	Third Vice-President
O. W. Israelson	Logan, Utah	Secretary
E. P. Ellison	Layton, Utah	Treasurer

DIRECTORS—JUDICIAL DISTRICTS

First District	Olof Cronquist	Logan, Director
Second District	D. D. McKay	Ogden, Director
Third District	A. F. Doremus	Salt Lake City, Director
Fourth District	R. S. Collett	Roosevelt, Director
Fifth District	Jas. A. Melville	Delta, Director
Sixth District	R. D. Young	Richfield, Director
Seventh District	Carl R. Marcussen	Price, Director

DIRECTORS—CONGRESSIONAL DISTRICTS

C. F. Brown	Salt Lake City	Director
Wilford Day	Parowan	Director

STATE AT LARGE

F. B. Hammond	Moab, Utah	Director
Jos. R. Murdock	Heber, Utah	Director

7. That all persons, associations or corporations interested in irrigation or drainage be eligible to membership."

The report of the Committee on Organization was unanimously adopted and the officers above named were declared elected.

Following the report, the Congress adjourned until 9:30 a. m. February 1st.

MORNING MEETING, SECOND DAY

Upon reassembling February 1st, at 9:30 a. m., the Congress was addressed briefly by Mr. J. C. Wheelon, second vice-president, who acted as chairman. Mr. Wheelon explained that Mr. R. D. Young was unable to discuss the question, "Are Settlers on New Irrigation Projects in Utah Making a Success? If not, Why?", and Mr. Wheelon asked Professor Israelson to speak five minutes outlining the significance of this question.

Prof. Israelsen's discussion was followed by a thorough treatment of the subject

IMPORTANT DRAINAGE ENGINEERING AND SOIL PROBLEMS

By R. A. HART

Senior Drainage Engineer, United States Department
of Agriculture.

"Drainage engineering is irrigation engineering plus."

The drainage engineer deals with many of the same factors which are of importance to the irrigation engineer, but the situation is more complicated. The drainage engineer is in much the same position as a mathematician called upon to solve an equation having two unknowns.

This subject was assigned me without my having had a voice in the matter. I am glad of it. I could not have chosen a better title to impress the fact that there are two great sets of problems in connection with drainage reclamation of irrigated lands, those of a strictly engineering nature, and those involving considerations of the properties of the soil.

Engineering and soil problems arise in connection with three phases of reclamation by drainage:

1. With the design of the drainage system.
2. With the construction of the drainage system.
3. With the subsequent treatment of the soil when drained.

Each of these phases involve questions relating to surface conditions, and to sub-soil conditions.

The layman is apt to lay too much stress on the surface factors, and to ignore sub-surface considerations. I continually receive requests from landowners asking me to "come up and stake out a drain." In some cases the letter goes on to say that the tile has been ordered and is on the ground.

Some engineers, who are pleased to consider drainage as a simple matter and who are content to follow haphazard methods, exhibit little more insight than the layman. I have heard of cases where landowners have hired engineers to lay out drainage systems and the landowners indicated that the lines should go here, and here and here. The engineer merely staked out the drains where directed and went his way. Naturally the system was a failure. The fundamental proposition that drainage of irrigated lands is a highly scientific proposition was entirely overlooked.

The successful drainage engineer is the one who has learned that the ordinary point of view must be reversed. Of course, surveys and other surface studies are necessary but the sub-surface investigations are vastly more important.

Nature herself, has determined the proper depths, locataion and arrangements of drains and by a study of the sub-soil structure we may ascertain the required facts as well as obtain an idea of the necessary capacity for the drains.

DESIGN

A topographic survey of the area to be drained is generally necessary. This may be made most satisfactory by means of a plane table. The areas in need of drainage as a rule have been cultivated, hence are free

from timber and high brush. The making of a map right in the field has many advantages, chief among them being that observations of existing conditions may be plotted while fresh in mind and that errors of the desirability of additional readings are at once apparent. One instrument-man can keep two or three rodmen busy and handle about a section of land per day. It is advisable to establish a system of signals and a system of B. M.'s running a base line between two signals, then running a line around each section and filling in later.

If possible the survey should be made subsequently to the making of the sub-surface studies in order that the ground surface elevations at the various soil borings and observation wells may be ascertained and their locations tied in.

In addition to showing topography, the map should show land divisions, properly lines, roads and lanes, railroads and interurbans, power, light and telephone lines, canals, ditches, water courses and bodies of water, tree rows, artesian and other wells, bridges, flumes, siphons, etc., and the drainage outlet conditions, and land conditions according to state of productiveness.

If no alidade and equipment are available, a transit having a long bubble may be used or a fairly satisfactory engineer's level having a compass attachment.

The purpose of the subsurface determinations is to ascertain the source and amount of the damaging water and to obtain an idea of the amount of water that it will be necessary to take care of. It is required to ascertain the nature of the soil, the depth to, and thickness of, various sub-strata, the relation of the ground-water table to these sub-strata and to the ground surface topography, the behavior of the ground-water table under various conditions of irrigation, rainfall and evaporation, and the seasonal variations of the depth to the ground-water table, and the effect of saturation of the soil.

The required data may be obtained through the agency of soundings, soil borings, observation wells, test pits and experimental trenches. Soundings may be made in a fluxible soil by means of long steel rods of small diameter. The chief purpose is to ascertain the presence of, and depth to, gravel, rock, shale, hardpan or clay. The application is not very extensive. Soil borings are made by means of earth augers, or soil augers built up of an ordinary carpenter's bit with gas-pipe stem and handle. The soil is removed by augers-full and examined visually or retained for subsequent mechanical and chemical analyses. Observation wells may be made with an earth auger and cased with perforated downspouting. Their chief purpose is to provide for the determination of ground-water fluctuations over a considerable period of time and to ascertain the effect of rainfall, irrigation, etc., on the ground water table. Test pits are usually dug with picks and shovels but small ones may be dug with telephone tools. They are necessary in case of gravelly subsoils and serve much the same purpose as soil borings beside offering a fair idea of the probable necessary drainage capacity. Experimental trenches are really a development of the test pit and serve the additional purpose of giving a fair idea of construction difficulties and costs. Let us examine some of the bearings of sub-surface conditions on the design of drainage systems. First of all there is the matter of locataion of drain lines. It is necessary to bear in mind that the movement of the damaging water, under irrigation conditions, is generally lateral. It follows that the interception method of drainage is generally applicable. The most usual location of injured lands is one of comparatively flat slope at the foot of a steeper slope. Experience shows that the logical location of a drain line is at the change of slope. Sub-surface investigation will likely show that the damaging water is moving

through a pervious stratum that either pinches out or suffers a change in slope which develops a pressure which forces the water to the ground surface. Manifestly the proper locataion of the drain is that at which the lateral seepage will be cut off before leaving the pervious stratum.

Under irrigaation conditions, the location of drains is the important thing—spacing of drains has little part in drainage practice. If more than one drain line is necessary, however, a study of the shape of the ground water curve will indicate the best spacing.

A study of the ground water table will indicate whether or not it is necessary to locate a drain line adjacent to a canal to catch direct seepage. The same is true of a situation where there is seepage from a shale knoll or a gravel ridge.

Next to proper location, the required depth is of greatest importance, and a study of sub-soil conditions is imperative. In the first place it is necessary that the ground-water table be lowered to a depth greater than that from which capillarity will raise moisture above the free water surface, in order that soluble salts may not be accumulated on and near the ground surface due to evaporation from the surface. A study of the soil itself in place is the best measure of this.

The location of a more-pervious or a less-pervious sub-stratum is also of importance. Referring again to the wet area at the change of the slope, assume that at the location chosen for a drain line, a previous stratum exists at a depth of from $6\frac{1}{2}$ to 7 feet and is underlain at the latter depth by clay. Now, if a drain is installed at a depth of 6 feet, the damaging water will continue to pass under it and the drain will not be effective. If the drain is laid at a depth of $6\frac{1}{2}$ feet the situation is even worse. Not only will the water continue to pass under the drain, but the tile being bedded in the previous material will not have a stable foundation and will be likely to get off of grade, out of line, and even upended and filled with sand. Obviously the drain must cut through the previous stratum and bed on the underlying stable material.

In case where the sub-stratum is of less-pervious material, the water will be found moving on top of the stratum and, here again, if the drain does not cut to the stratum, it will not be successful. No advantage will accrue, however, by cutting the drain into the stratum except so far as is required to afford good bedding.

Even if the soil is fairly homogeneous in structure, much may be learned as to the best depth to afford by a study of the sub-soil conditions.

The determination of the required capacity of drains by reference to subsoil studies has not yet been worked out so conclusively as some of the other factors, but enough work has been done to show that close estimation by such a process is possible. Formerly design for capacity was based on rule-of-thumb procedure or much was left to the judgment of the designer. Very early the Egyptian practice of providing for a drainage run-off of one third the irrigataion supply was adopted, but experience soon showed that the drainage run-off might vary from a small percent of the irrigation supply to several times the irrigation supply. The system of basing the probable discharge upon the length of the drain was proved equally useless.

It is quite apparent, however, that there is a definite relation between the required capacity of drains and the behavior of the ground-water table before drainage. Obviously, it is the prime purpose of drainage to remove the surplus water from the soil and to prevent fluctuations of the water table above a certain prescribed plane. It is obvious that a measure of the surplus water in the soil is the difference between the total void space of the soil and the capillary content. This latter may be approximated by soil-moisture studies. Then if we have a record of the fluctuaations of the ground-water table we can easily

determine the actual amount of water necessary to be removed to prevent the dangerous rise.

An interesting method of designing for required capacity of drains was recently developed in which no moisture-content or void-space determinations are required and where all studies are on a field scale. It is applicable only where the ground-water table is within capillary distance of the surface and where, owing to rains or recent irrigation, the moisture content is at the capillary capacity point. By measuring the rise of the ground-water table due to a measured precipitation or irrigation, the difference between the void space and the capillary content of the soil can be determined directly and this is precisely what is desired.

Up to this point we have been considering only the matter of excess of moisture in the soil. As a matter of fact, all arid soils contain a greater or less amount of soluble salts and as a rule waterlogging is followed by an accumulation of these salts to an extent that is detrimental to plant growth. Without going into a discussion of the nature of these salts or their effect on plant growth we will pass on to a consideration of their bearing on problems of design.

The accumulation of an excess of salts on and near the ground surface is the result of evaporation of moisture from the soil while the ground-water table is within capillary distance from the surface. As has been said, it is necessary to place drains deeply enough so that the ground-water table is within capillary distance of the surface. Now the capillary rise of water is both increased and expedited by the presence of soluble salts and this effect is worthy of consideration. Furthermore, if there is a great excess of salt present it will be necessary to leach out the ingredients by means of copious applications of irrigation water. This calls for a more capacious system than the actual drainage needs demand. Moreover, it is often desirable to expedite the removal of salts as much as possible, so that a minimum number of crops will be lost. This calls for a closer spacing of drains than would otherwise be required. The drainage engineer frequently has some nice problems in economics to work out.

The determination of the nature and amount of salts present in the soil may be made by analyses of soil samples during sub-surface studies. These analyses may be made by the electrolytic method or by evaporation of filtrates as far as total salts are concerned, but the chemical analyses must be made in order to determine the proportions of the constituents.

CONSTRUCTION

From the construction standpoint the most important problem is the effect of waterlogging and accumulation of salts on the soil and on vegetation. Arid soils lack humus and are generally very fluxible when satisfactory, while the destructive effect of the salts on vegetation results in a lack of sod which in other instances acts as a binder and provides a fairly stable surface foundation for field operations.

In case of fluxible soils great difficulties during construction are encountered owing to the caving of banks of drainage trenches, and the miring of horses, wagons and machinery. Cost naturally runs very high under such conditions and a system when completed is not so nearly perfect nor so satisfactory as might be desired.

One of the drainage engineer's hardest problems has to do with human nature. Landowners will not install drains until the ground-water rises so high that the soil is converted into mire, salts are accumulated to a very harmful degree, vegetation is all killed out, crops are lost, and the land owner up to his neck in debt and with no source of income to pay for drainage work, which under such a condition as then exists will cost two to four times what it otherwise would. The

average life of drainage engineers would be probably increased by ten years if landowners would only drain their lands at the right time, which is the moment the ground water table gets above a safe depth, which generally is in the neighborhood of six feet from the ground surface. Lacking this, the drainage engineer must determine at what season of the year the ground-water table is the furthestest from the surface and install systems at such a period if possible.

Another problem involving human natures arises in this connection. It is highly important that no irrigation operations be conducted on or near a tract being drained, but do you know, it is always highly important that the old miry, alkaline, God-forsaken, salt-grass bog must be irrigated just exactly when it will do the most harm, even if the drainage engineer can guarantee that he will make sugar-beet land out of it in six months' time if the farmer let it alone? Why, it would pay big if the whole farm were left to parch and burn up that season.

Special methods and devices have been developed to handle the situation where fluxible soils are involved, but time does not permit of a discussion of these. As a matter of fact, the drainage engineer must make continual modifications of these during construction, soil conditions frequently changing within a space of a few feet and sometimes being absolutely different on the two sides of a trench less than two feet in width.

The selection of machinery for trenching can be made only after a very careful study of the sub-soil conditions and frequently the whole question of success depends on the choice of machinery.

SUBSEQUENT TREATMENT

The drainage engineer recognizes artificial drainage as only supplementary to natural drainage and that drainage is only a basis for reclamation for alkaline lands and not the reclamation itself. The reclamation of alkaline lands depends upon the percolation through the soil of sufficient quantity of water to dissolve, leach out and carry to the underdrainage the accumulated salts. A portion of the dissolved salts are removed by the drainage system but a large part are merely redistributed throughout the soil column. It is quite evident, therefore, that the drains must be ever operative, otherwise a subsequently rising water table would result in a new accumulation of salts.

It has been found necessary to spread the leaching water over as large an area as possible, to keep the depth as uniform as possible and to have the subsequent drying out take place as uniformly as possible or there will be merely a translocation of salts and not a proper removal. If the ridges or knolls extend above the water surface during flooding there will be an accumulation of salts on the ridges or knolls and if one area is flooded while an adjacent area remains dry and subject to evaporation, it is likely that salts will move laterally and the content of the dry area be actually increased.

The actual amount of salts removed from soil by a leaching process is startling. As an example, a certain tract of 11 acres was recently reclaimed. Six months after the drains were installed, and as a result of a single flooding 2000 tons of salts were removed. This is at the rate of 116,000 tons per square mile, or over 7,000 carloads per square mile."

Mr. Hart's paper was discussed by C. F. Brown, Drainage Engineer, who pointed out some limitations to practical depth of

drains. Mr. Brown also presented some lantern slides vividly picturing drainage conditions.

Professor Israelsen thereupon presented the following resolutions which passed unanimously:

RESOLUTIONS

Be it resolved by the Utah Irrigation and Drainage Congress that The Governor and Legislature of the State of Utah be urged to create an Irrigation and Drainage Code Commission; the duties of which shall be:

1. To fully investigate irrigation and drainage laws of Utah and all other states in this country and also the laws of other countries.

2. To prepare a code of laws upon the basis of such study and investigation which will improve irrigation and drainage conditions in this State and which will give special consideration to the speedy determination of vested water rights in Utah.

3. To begin its investigation not later than 60 days after the enactment of the law creating the Commission and to make its report not later than September 30, 1918.

4. That the Commission consist of three members and that each member shall have had thorough training and practical experience in irrigation and drainage matters, and in water right problems.

The advisability of endorsing the Chamberlain Bill was submitted. Upon motion of Mr. Brown it was left to the Trustees of the Congress with power to act.

The Congress was adjourned by Chairman Wheelon.

Below is a list of contributors to Irrigation and Drainage Congress Work, February 1, 1917:

David McKay.....	\$ 1.00
John T. Caine, Jr., Logan.....	.50
E. N. Austin, Salt Lake City.....	1.00
Clarence Austin, Garland.....	.50
B. F. Bingham, Logan.....	.50
G. N. Judah, Logan.....	.50
H. S. Hulse, Millville.....	1.00
S. R. Telford, Richmond.....	.50
S. F. Wiser, Lewiston.....	.50
Jos. Potter, Cleveland.....	1.00
Jos. Smith, Sugar Station.....	.50
George E. Brown, North Ogden.....	.50
H. J. Walk, Z. C. M. I., Salt Lake City.....	.50
Wm. Cook, Hyde Park.....	.50
H. B. Woodbury, Salt Lake City.....	.50
N. P. Peterson, Sugar Station.....	.50

R. V. Call.....	.50
O. W. Jarvis, Logan.....	.50
J. C. Wheelon, Garland.....	1.00
Wm. Bingham, Logan.....	.50
George T. Oveatt, Elinor Erie Company.....	1.00
Hyrum W. Hanson, College Ward, for Spring Creek Irrigation Company, Cache County.....	.50
Carl M. Nelson, Logan.....	.50
	<hr/>
	\$14.50

MEETING IN SALT LAKE CITY FEBRUARY 28, 1917

President Mathonihah Thomas called a meeting of the Utah Irrigation and Drainage Congress to convene at Salt Lake City, in the evening of February 28th.

At this meeting Dr. F. S. Harris offered to the Congress, free of charge, the assistance of the Experiment Station clerical force.

The presidents of the Congress along with the secretary, were instructed to provide by-laws and a constitution to be presented at a meeting early in April, 1917. They were also instructed to arrange for a complete program for the April meeting.

Prof. John T. Caine III invited the Congress to meet at Logan annually during the period of the roundup, or immediately before or after the roundup week.

APRIL MEETINGS, 1917

The meeting of the Congress, arranged for in the February meeting, convened at the Hotel Utah at 10:30 a. m. on the fourth of April, 1917, with President Thomas in the chair.

The first business of the meeting was the adoption of a constitution and by-laws. After a few minor changes in the original drafts, the following constitution and by-laws were unanimously adopted:

CONSTITUTION OF THE UTAH IRRIGATION AND DRAINAGE CONGRESS

ARTICLE I

The name of the organization shall be the Utah Irrigation and Drainage Congress.

ARTICLE II

The object and purpose of this organization shall be the dissemination of information pertaining to irrigation and drainage, especially in the State of Utah, and to encourage the development of legitimate irrigation and drainage enterprises; and to further the interests of the State of Utah in the conservation of its water and to advance the interests of the State and its inhabitants perfecting and protecting all irrigation and drainage interests.

ARTICLE III

The officers of the Congress shall consist of the following:

A president; first, second and third vice-president, a secretary and a treasurer, which together with one director from each of the seven judicial districts of the State; and one from each congressional district, and two from the State at large, shall constitute the board of directors and shall be the Governing Board of the Congress, and shall hold office for one year and until their successors are elected.

The officers for the first year shall be:

Name	Address	Office
Mathonihah Thomas, Salt Lake City, Utah.....		President
W. D. Beers, Salt Lake City, Utah,.....		First Vice-President
John C. Wheelon, Garland, Utah.....		Second Vice-President
A. F. Cardon, Logan, Utah.....		Third Vice-President
O. W. Israelsen, Logan, Utah.....		Secretary
E. P. Ellison, Layton, Utah.....		Treasurer

DIRECTORS, JUDICIAL DISTRICTS

First District, Olof Cronquist, Logan.....	Director
Second District, D. D. McKay, Ogden.....	Director
Third District, A. F. Doremus, Salt Lake City.....	Director
Fourth District, R. S. Collett, Roosevelt.....	Director
Fifth District, Jas. A. Melville, Delta.....	Director
Sixth District, R. D. Young, Richfield.....	Director
Seventh District, Carl R. Marcussen, Price.....	Director

DIRECTORS, CONGRESSIONAL DISTRICTS

C. F. Brown, Dooly Bldg., Salt Lake City.....	Director
Wilford Day, Parowan.....	Director

STATE AT LARGE

F. B. Hammond, Moab, Utah.....	Director
Jos. R. Murdock, Heber, Utah.....	Director

ARTICLE IV

The President shall perform all duties incident to the office and appoint all committees, unless the Congress shall expressly do otherwise. In his absence from the State, or from disability, the vice-presidents in the order of their seniority shall act as president.

The Secretary shall perform the duties incident to his office. The Treasurer shall perform the duties incident to his office and shall be custodian of the funds.

This Constitution may be amended from time to time by a two-thirds ($\frac{2}{3}$) vote of the members present at any regular meeting, or at any special meeting called for that purpose.

ARTICLE V

All persons, associations or corporations, private or municipal, engaged in irrigation or drainage, directly or indirectly, or who are interested in the furtherance of the purpose of this Congress, shall be eligible to membership, under such rules and conditions as the directors may from time to time, impose through By-Laws.

(Signed)

MATHONIAH THOMAS,
President.

W. D. BEERS,
First Vice-President.

J. C. WHEELON,
Second Vice-President.

A. F. CARDON,
Third Vice-President.

O. W. ISRAELSEN, Secretary.

E. P. ELLISON, Treasurer.

BY-LAWS

UTAH IRRIGATION AND DRAINAGE CONGRESS

ARTICLE I—MEMBERSHIP

Section 1. The membership of this organization shall be composed of persons, associations or corporations within the State of Utah, or elsewhere, who are interested in and will lend their assistance to the promotion of the purposes of the Congress.

Section 2. There shall be three classes of membership. Life membership shall be issued upon payment of a membership fee of \$15.00, which shall be invested by the Board of Directors, as a permanent endowment fund, the income from which shall cover all expenses in connection with such membership, including a copy of the Proceedings of the Congress. Annual memberships shall be issued on payment of One Dollar (\$1.00) per year, which price shall include a copy of the Proceedings of the Congress. Honorary memberships, for which no fee shall be required, may be conferred in particular cases by a majority vote of the Board of Directors.

ARTICLE II

Section 1. The elective officers of the organization shall consist of a president; a first, a second and a third vice-president; a secretary and a treasurer, which said officers shall, with a member elected from each judicial district, one from each congressional district, and two members from the State at large, constitute the Board of Directors. The term of office shall be for one year.

Section 2. The Board of Directors shall have charge of all business of the Congress, fix the time and place for annual and other meetings, and prepare suitable programs.

Section 3. The Board of Directors shall fill any vacancies occurring in an elective office until the next annual meeting.

Section 4. The Board of Directors shall also act as a committee of finance to invest the funds of the Congress, and shall appoint a committee of three members to audit the accounts.

Section 5. The Board of Directors shall be a committee on legislation to carry out the directions of the Congress at its annual meeting in regard to legislation.

Section 6. The Board of Directors shall employ such assistance as will enable it to perform the duties imposed on it by the Congress.

Section 7. The President of the Congress shall be chairman of all meetings of the Congress and of the Board of Directors, and shall call all meetings of the directors at his own instance, or as agreed upon among the Directors.

Section 8. Upon failure of the President to call a meeting, any three directors may call such meeting as the business of the Congress shall warrant upon giving ten days written notice thereof to each director. Five directors shall constitute a quorum to transact the business of the Congress.

ARTICLE III—COMMITTEES

Permanent committees of the organization shall be as follows:

Section 1. A committee of seven on nomination shall be elected each year by the membership of the Congress at the annual meeting thereof. The duties of this committee shall be to select and place in nomination not more than three candidates for each office to be filled.

Section 2. A committee on Resolutions, consisting of seven members shall be appointed by the president at the first session of each convention.

Section 3. A standing committee on Membership, consisting of seventeen directors.

Section 4. A standing committee on Publicity, consisting of three members.

Section 5. And such special committees as may be designated by the Congress shall be appointed at the last session of each annual meeting by the newly elected president for the ensuing year.

ARTICLE IV—AMENDMENTS

These By-Laws may be amended at any meeting of the Board by the majority vote of those present.

After the adoption of the Constitution and By-Laws, President Thomas discussed recent irrigation legislation. He emphasized the duties of the Utah Water Rights Commission and outlined the purposes of the new Irrigation District Law.

EVENING MEETING

At the evening meeting Mr. W. D. Beers read a paper on "Problems in the Management and Operation of Irrigation Systems."

Mr. C. F. Brown presented a paper on the drainage of irrigated farms, which is given below:

"DRAINAGE OF IRRIGATED FARM LANDS"

By C. F. BROWN

Civil Engineer, Salt Lake City.

I desire to take up this subject under four heads:

1st—The contributing factors producing needs of drainage.

2d—Preventative Measures.

3d—Construction Features, and

4th—Results attending proper drainage.

When it is considered that there are something like 300,000 acres of land in the State of Utah once fertile and productive but now rendered unproductive by accumulations of alkali and surplus waters, there need be no excuse offered for discussing drainage.

There is now from one-third to one-half of the total irrigable land in the State of Utah that is unproductive on account of excess water. This trouble is not confined to Utah; it is found in all of the arid states of America and in all irrigation projects the world over. It has long been a problem confronting practical irrigationists, and was recognized as early as 1875 by the English Government in attempts to reclaim the barren wastes of India, and a special inquiry was sent to Salt Lake City at that time for the purpose of studying the results following irrigation in this section. It had been reported that the Mormons had been very successful in applying water to the alkaline wastes of the American Desert without the resultant evils of alkali and seepage.

At this time the Mormons thought that they had solved the problem, but later years have shown that the country was too new, that the soils were deep enough to be taking care of the surplus waters that were applied in irrigation to such an extent that accumulations of water and injurious alkaline salts following irrigation had not yet arisen.

After from twenty to thirty years of irrigation, these results began to show very appreciably, and the injured areas have extended gradually year by year. Ten years ago, a movement was undertaken by the U. S. Department of Agriculture and the Utah Experiment Station for the purpose of developing the best methods of reclaiming these waste lands by drainage.

Early experiments showed that the methods of tile drainage adopted in humid countries were not applicable to arid regions, and therefore a series of experiments was begun for the purpose of developing the proper methods of draining these lands. This work has now proceeded beyond the experimental stage. We are just beginning to recognize in these abandoned and waste lands, now fit only for pasturage, a valuable asset.

Proceeding with the first division, "The contributing factors producing the needs of drainage," I desire to call your attention to that one which is first, as it begins with the canals where the water is first diverted from the mountain streams for irrigation, but while there are great losses of water from canals and laterals, the total water lost in this division of irrigation practice is much less than in some of the other divisions or in all of the other divisions taken together.

Referring to the losses in canals and laterals, a recent bulletin published by the U. S. Department of Agriculture by Fortier, 126, makes the statement that of all the canals in the United States the average

loss from seepage, evaporation, etc., aggregates 40 percent of all the water taken in at the entrance.

The losses of water from evaporation are relatively small in canal sections as they depend primarily upon the area of the water surface exposed which is a minimum in this instance, so that we can charge seepage and deep percolation up with practically the whole 40 percent of the water which is lost between the canyon streams and the land.

The second contributing factor which causes the great need for drainage is deep percolation attendant upon irrigation which thus wastes from one to two times as much water as the crops require. This matter has been made the subject of extensive experiments, measurements, and observations, and the proper quantities of water have been determined for the growth of all the crops that are practical in this section of the country. In looking over the records of performance of the several canals throughout the State, we find that from two to three times as much water is used and applied to the lands in question, measured at the farm intakes, as is necessary for crop production.

The third contributing factor to the needs of drainage is the waste water which is allowed to run from irrigated fields, flooding the roads and waste lands to such an extent that large portions of this water find their way into the soil, raising the ground water table and ultimately doing the damage which results from waterlogging. In my judgment, the amount of water lost and wasted, and doing damage to the lower lands, coming from the surplus waste running off irrigated fields, will range from 10 to 25 percent of the amount of water required for successful growth of crops.

The fourth contributing factor to be taken up here is the naturally alkaline soils which require more water than they can successfully handle and which is necessary to be applied in copious quantities for the removal of the alkali present in such soils.

The first three factors are all capable of regulation which will be discussed under the heading following as "Preventative Measures."

The fourth factor cannot be eliminated nor can remedial measures be applied to this until the surplus of the alkaline salts is washed out. Then these lands will be free from alkali and will not require the same amount of water.

In discussing this subject, we are prone to think only of the construction features and the methods by which lands are drained and reclaimed, forgetting at the same time that we should begin with preventative measures to reduce the amount of water that is thus wasted, the saving being two-fold; first, in making the water go much farther than it goes now in developing the resources of the western part of the United States; and second, in removing the chief causes for the deterioration of the irrigable areas which have been injured by seepage water accumulations and extensive alkaline salt accumulations.

The first preventative measure that should be considered and the one which is now being practiced to some extent is that of lining canals and laterals with impervious materials for preventing water loss by deep percolation.

Up to the present, very little has been done throughout the irrigated West, except in places where the seepage was so great that the canals would not pay for operation on account of the great losses of water in particular sections. In some instances these sections have been lined with concrete, which has been found to be the most serviceable, and the most economical form of canal lining.

In Utah, most of Nevada, portions of California, all of Washington, Oregon, Idaho, Montana, Wyoming, and Colorado, severe freezing weather makes it necessary to use thick canal lining in order to insure its

permanency against the heaving action of frost. Recent improvements point to a reduction of 50 percent in the cost of canal lining, thus making it possible to line double the amount of lineal feet of canals with the same amount of money that has been used heretofore.

One of the largest jobs of canal lining which has been undertaken of recent years was the contract let by the Twin Falls South Side Canal Company, to line a 6000-foot section of their main canal which has a bottom width of 30 feet, a top width of 70 feet, and a depth of 6 feet. This section of canal is being lined with a 4 inch thickness of concrete at a cost of \$65,000 or approximately \$11.00 per lineal foot. This canal company has 14 miles of such canal to line, and has begun a policy of lining at least a mile a year, so that it will take fourteen years to line this section of canal. By that time, the canals that are now considered to be efficient will have been considered inefficient with the growing value of irrigation water and the increasing value of the canal system so that other canal lining will be undertaken.

Measurement of canal losses in this section were made in 1906 on a section of canal 7.79 miles in length, showing a total of 194.7 cu. ft. per second or 11.5 percent of the water carried.

Another measurement on the section of the same canal 3.35 miles in length was measured in 1912, showing a loss of 167 cu. ft. per second, or 5.2 percent of the total water carried.

The Weber and Davis County Canal near Ogden has been lined around a portion of the Sand Ridge, and is working very successfully. The Utah Lake Irrigation Company is preparing to line their canal around the Point of the Mountain in the south end of Salt Lake County.

The Logan, Hyde Park & Smithfield Canal, Logan River, in a section 1.32 miles long, lost 21.3 cu. ft. per second or 44.4 percent of the total water carried.

The Bear River Canal line, Bear River Canyon, 5 1-2 miles shows a loss of 70.7 sec. ft. or 16.7 percent of the water carried, as shown from measurements in 1902.

The Cottonwood Canal, St. George, with a length of 14 miles, shows a loss of 3.17 sec. ft. or 45.1 percent of the total water carried.

The Prosser Falls Irrigation Company lateral, Yakima River, Washington, over a length of .38 miles, shows a loss of .32 second foot or 64 percent of the total water carried.

These are only a few instances showing the tremendous losses that occur in canals and laterals throughout the irrigated sections and covering all classes of formation and conditions found in practically all of our irrigation projects needing attention, affording excellent opportunities for increasing the efficiency of the water now applied, or, rather wasted, which very conservatively will double the amount of land capable of being irrigated and being rendered productive by the application of the proper engineering methods in lining canals for the purpose of preventing these wastes.

The second preventative measures in irrigation, and the factor by which the greater percent of loss occurs, is that of the use of better methods of applying water, reducing the losses from deep percolation to a minimum. This is a matter which will have to come through the education of the irrigators themselves—the men on the farm, the farmers who lay out their irrigation systems, who determine the length of the furrows or runs between checks, and who have the actual handling of the water after it is delivered to the farm. When our farmers are sufficiently educated along these lines to appreciate the enormous waste that is attendant upon their usual methods of irrigation, they will more than double, probably treble the number of acres that can be properly irrigated with the same amount of water that they are using, and at the same time remove one of the greatest factors producing these

deficiencies. They can do this in two ways: first, by limiting the length of run of irrigation water; and second, by very careful manipulation of surface flooding. When water is allowed to run for a long time in one place, in order to reach the length of the furrows on the lower end, or in order to reach the lower end of the flooding division, the greater part of the water applied is lost for all practical purposes by deep percolation and seepage to arise on the lower land and contribute a large part of the surplus water which has injured so many thousands of acres of fertile fields in this State and surrounding states.

To illustrate the amount of water that is applied to lands under irrigation, I have taken a few figures from the Big Cottonwood Creek system in Utah that will show the quantity of water used in depth in acre feet, and the acres irrigated per cubic foot per second. These figures include the losses from seepage and deep percolation in canals and laterals, and as we have shown before that such losses average about 40 percent, we may safely say that we can reduce this amount by 50 percent.

The Butler Ditch applied 6.24 acre-feet of water on every acre of land or irrigated 53.72 acres per cu. ft. per second.

The Brown and Sanford Ditch applied 5.32 acre-feet with a cubic foot per second duty of 63.01 acres.

The Upper Canal applied 6.3 acre-feet with a duty of 51.03 acres per cu. ft. per second.

The Green Ditch applied 4.52 acre-feet, giving a duty of water 71.97 acres per cu. ft. per second.

The Lower Canal applied 2.83 acre-feet with a duty of water 104.43 acres per second foot.

The Big Ditch applied 3.09 acre-feet with a duty of water 95.64 acres per cu. ft. per second.

The average depth applied on all these ditches is 4.8 acre feet. Assuming that the loss in canals and laterals is 50 percent, we have still to account for by the irrigation 2.4 acre feet per acre per annum, which is a very conservative estimate, and is exactly twice as much water as should be applied and as needs to be applied for the successful growth of crops in this section of the country where we have an annual precipitation of 16 inches per annum. This shows that it is perfectly possible for the irrigators themselves, the farmers, to double the area of irrigated lands in the irrigated sections, by better methods of applying water to the farms, by producing double the crops at a greater percent of profit than they are doing at the present time.

Another method of preventing the increase in the area requiring drainage, will be the prevention of waste water from running off the irrigated lands into ponds along the road and over unused land, thereby reducing the amount of water finding its way into the soil. In addition to carrying off this water and wasting it, the farmers who allow this practice to prevail, are simply washing off the surface of their soils. They are truly wasters of their substance, and should be called to account for this practice. In this time scarcity of food products and the great demand being made on the agricultural resources of our country, this waste should be prevented at once. They waste their substance, they prevent other lands from producing that which they are capable of producing, and in addition, they injure and render unproductive hundreds of thousands of acres by this reprehensible method of applying water.

In considering the third division of this discussion, "Construction Features", as applied to drainage of water logged and alkaline ground, I desire to mention a few particulars that are necessary, and to emphasize some portions which are but imperfectly understood at present.

1st—The location of the particular source of seepage as it flows into

the soil requiring drainage is an essential of good drainage engineering. This is the foundation or basis upon which successful reclamation by drainage rests. It cannot be determined except by the experienced engineer or agriculturist who has made the movement of ground water a study and who is capable of applying the principles of physics and hydraulics to the solution of this problem. This information determines whether the water comes to the soil under a pressure from higher elevation flowing from the more previous strata below upward through the soil pores or whether it comes to the farm in question by lateral seepage from higher lands and needs to be intercepted.

The solution of this problem depends upon the soil formation and the extent to which such soil surveys have been made. The usual methods of obtaining such information is by boring holes, digging wells, and collecting data concerning the soil from available sources, such as the structures encountered in digging and boring wells. In this connection, it will also be necessary to determine the character of the soil for the purpose of determining the qualities of the particular soils being examined as affecting the movement of soil water to the drains. The necessity for knowledge of the geological formation of the soils is for the purpose of determining the depths of drainage and the spacing between tile lines.

It is a principle of soil physics that the coarseness of grains, porosity, and the percentage of fine material comprising the soils has a tendency to affect the movement of water between grains. As it is necessary to lay tile so as to allow a minimum hydraulic gradient at practical spacing, it can readily be seen how a knowledge of underground conditions enters into the determination of the depths of drains.

It is necessary also for the purpose of determining the spacing or distance between tile lines. Underground surveys are necessary for discovering the existence of formations affecting the outlet and the possibility of relieving water under pressure. This feature of the drainage of irrigated lands is a question that is not very well understood and not generally recognized. Conditions, however, have been encountered in various parts of the arid region, necessitating the exploration and the construction of drainage works in the soil to depths of 45 ft. below the surface. One notable instance of this condition arises in the Snake River Valley under the Twin Falls project, in the lava formations. In this particular instance, the water which does the damage, is conveyed from the higher lands and from the canal losses to the lower lands chiefly through a porous stratum ranging in depth from 35 to 40 ft. below the surface.

Ordinary tile drainage is of no avail under circumstances if this kind, and in this connection it became necessary to drill wells from the ordinary depth of tile drains, 5 to 8 ft., to a depth of 45 ft. through the lava, through which the water which was being held under pressure rose to the surface through the fissured lava and porous soils overlying this formation, thus waterlogging and rendering alkaline the areas affected. By means of these wells, it was possible to relieve the pressure or furnish an outlet through which the water flowed with less resistance than through the soil, and each 8 inch well bored through the overlying formation cut off the seepage from an area of approximately two acres.

Another instance of a formation of this character has come up in connection with our practice at Richfield, Utah, involving the drainage of the High School site there, in which the water was contained and brought to the land in a coarse gravel stratum at a depth of 40 ft. below the surface. As it was impractical to lay drains to a depth of greater than 20 ft., which was all of the depth necessary for the foundation and basement of the High School, it is proposed, and construction work

is now being carried on to sink at least two wells down to the underlying gravel stratum for the purpose of relieving the pressure below.

The next division under "Construction Features" is that of surface surveys and layouts. I will touch lightly on this question as it is one that is generally understood by engineers; the practices are standardized, even laymen understanding the need of proper topographical surveys and location surveys for mains and laterals so as to secure the maximum slopes for drainage.

Methods of trenching and laying tile have been more or less standardized, and are matters of common knowledge. I do not deem it advisable to go into detail in this relation at the present time because of the general understanding of the subject. Several bulletins have been published, and are available for distribution by the U. S. Department of Agriculture and the Utah Experiment Station. Portions of these bulletins dealing with the bracing of trenches by means of a protecting shield behind the wheel for laying tiles and the use of gravel and sand for foundations of tile and for filter purposes, with a view to keeping out the salt and fine sand, should be made the subject of special study.

The outlets for drainage in the arid sections are practically all of the gravity type. In portions of the humid sections and portions of some projects in the arid regions where lands are located in low valleys with water near the surface, it has been found advisable to conduct the drains to some low portion or sump from which the water may be pumped and conducted away from the lands by surface ditches. The pumping lift as a rule ranges from 6 to 10 feet. This pumping is not an expensive proposition, and in many instances need be only an auxiliary plant in connection with gravity outlet, as the water surface furnishing the outlet recedes during the latter part of the season to such an extent that the pumps can be closed after a few months operation until the return high water stage.

The kind of construction here employed is that of draining into the sumps from which tide gates will allow the water to flow out when there is no back pressure, and which will keep the water from flowing in from the gravity outlet, burdening the pumping plant when the latter needs to be in operation. This method of construction is practiced by the Logan Land & Drainage Company Project on the Logan River. It is expected to have to pump here approximately two months during Spring. The balance of the year, the water will flow out by gravity. It is necessary to pump only for the lower portions of this project, the balance draining out by gravity during the whole year.

In concluding this paper with the "Results Attending Proper Drainage," I want to call attention to two subjects that have been covered more or less by other engineers and agriculturists, and then point out one or two which have not received as much attention. One of the first benefits resulting from tile drainage will be that due to the improvement of the mechanical condition of the soil, by lengthening the growing season and with better crops under more favorable conditions for soil bacteria and the production of plant food. The season is lengthened by the earlier drying out of the lands by reason of the tile drains. This is true where crops are grown on lands not deemed to be in need of drainage. Experience has demonstrated the fact that crops grown on drained lands are as good or better than those grown on lands generally thought to be free from the need of drainage. Water conditions may not be sufficiently bad to make drainage imperative, but in many instances would justify the cost.

The time is rapidly approaching when thousands of acres not now deemed to be in need of any artificial drainage will be tile drained for the advantages mentioned above. One of the beneficial effects resulting

from tile drainage and one which has been but imperfectly understood is the value of irrigation water thus developed and conserved which may be used for the irrigation of other lands for which there is not water at present. The value of irrigation water is the real basis for estimating or determining the productive capacity and earning power of the lands in arid regions. There are a great many acres of land in the State of Utah and surrounding states not capable of producing crops without irrigation. These lands lie adjacent to irrigated and cultivated areas, and any conservation of the water now applied really means the extension of the resources of the several localities through the agricultural development that may follow.

As examples of the beneficial results following drainage, I desire to mention one or two instances. The first one is that of the farm of S. H. Lamb of Hyde Park, lands that produced very abundantly up to 20 years ago. They subsequently became very badly water-logged and alkalined to some extent, and were valuable only for summer pasturage, bringing returns on a valuation of not more than \$10.00 per acre. Mr. Lamb produced, subsequent to drainage, from 25 to 30 tons of sugar beets per acre; I was there during the harvest of one of these crops, and can truthfully say that I have not seen better crops grown in the State. Mr. Lamb told me he would not take \$500 per acre for the land, as it would produce 10 percent on this valuation over and above the expenses of growing the crop, fertilization, property and water taxes. Lands completely ruined in the Bear River Valley by accumulations of water and alkali and which have been unproductive from one to ten years, were reclaimed at an expenditure of \$18.00 to \$20.00 per acre, and produced crops of from 16 to 20 tons of sugar beets per acre, and crops of oats yielding from 60 to 75 bushels per acre the first year after drainage.

There are many other notable instances of improvement following the installation of tile drainage.

In conclusion, I desire to express the opinion that we are now entering upon a period of conservation of agricultural resources which will be one of the most effective and practical that has been undertaken in the last fifty years.

Mr. McPherson in leading the discussion of Mr. Brown's paper said that the Delta Land and Water Company has drained five thousand acres of alluvial soil; having used two Bucy-Eye trenching machines and one P. & H. machine. The machines have been highly successful, and very large quantities of alkali salts have been removed with the drainage water, the flow of which is approximately five cubic feet per second. The many boggy places formerly existing in the soil have disappeared.

Mr. L. M. Winsor asked Mr. McPherson concerning the success of planting sweet clover, and was advised that drainage was only a preliminary step in the reclamation of land and that the sweet clover had contributed very largely to the success of reclaiming various types of the Delta project. Mr. Winsor announced that he would be pleased to obtain the results of Mr. McPherson's experience for pointing out to the various persons

in the State the value of sweet clover. Mr. Dresser of Delta confirmed the statement of Mr. McPherson, stating that he too had been very succesful with this crop.

In reply to questions by Mr. McPherson, Mr. Winsor pointed out that in Salt Lake Valley sweet clover was cut with a self-binder, and that very little shelling occurred. Moreover, the time of threshing was not a difficult problem.

In reply to request by President Thomas, Dr. F. S. Harris pointed out the urgent need for an organization of the type of the Irrigation and Drainage Congress, and assured the members that excellent success would come if continuous efforts were made toward the solution of these problems.

Mr. Winsor announced that he would like to hear some of the experiences of Mr. R. S. Collett in the organization and promotion of the Dry-Gulch Irrigation Company.

Responding to President Thomas, Mr. Collett took the floor and said in part: "The farmers of the Uintah Basin have met many new problems and are solving them gradually. However, these papers are of great value, and I am sorry that we could not have had a large representation of our farmers here at this meeting today. The Uintah Reservation was opened in 1905, and settlers who entered were of a very composite nature, having come from many states. There were no experienced irrigation men. There were approximately five hundred homesteaders, covering an average area of 80,000 acres. Mr. Joseph R. Murdock suggested the idea of organizing these holders into one mammoth irrigation company, whereupon the speaker was chosen chairman to bring the homesteaders together and organize an irrigation project. Upon learning of the proposed organization, a few men in the Uintah Basin filed on large quantities of irrigation water. However, after the organization of the company, having a capital stock of \$200,000, these filings were easily obtained by the Company which represented the bona fide irrigators of the Basin. The first meeting of the Company was held at Roosevelt, May 15, where stock was sold at 10c per acre or \$16.00 for 160 acres. Mr. Collett was elected President of the Board of Directors. Other members of the Board were Mr. Holms, a soil expert, also men from various other states, including Nebraska and Kansas. The members of the organization had very little cash, consequently took for assessment a considerable amount of labor, having completed \$27,000 worth of work by making only \$1500.00 cash payments.

Many perplexing problems confronted the company; particularly the matter of finance. However, representatives were sent to Salt Lake City, and a loan of \$20,000 was obtained, which made it possible to tide over the most difficult season. This money was distributed to the various land owners. Finally the credit of the company became well established, the moral obligations were removed, the stock was classified, and water was delivered at an annual maintenance cost to the general office of only 8c per acre. The various tracts were classified according to locality, into Class A water, Class B water, Class C water, and so on. There are now 660 holders in the company, which represent very strong and successful farmers. The company recently borrowed \$30,000 on note without difficulty. Approximately one-half million dollars worth of work has been done, and the present liabilities are only \$35,000. Money is frequently transferred from one class to the other, which makes it possible for small units to succeed thoroughly. The company now proposes to build several storage reservoirs.

The President of the Congress, after Mr. Collett's description of the Uintah Basin work, announced, according to the Constitution and By-Laws adopted, the names of the Committee on Publicity as follows:

O. W. Israelsen, Chairman, and
 L. M. Winsor, and
 D. D. McKay.

It was decided by unanimous vote to extend to Mr. George O. Relf, Manager of the Hotel Utah Operating Company, a vote of thanks for his kindness in permitting the Congress to convene in the Hotel Building. The Secretary was advised to inform Mr. Relf of this action. Motion by R. D. Young for adjournment was carried. The Congress was adjourned.

MEMBERS OF THE UTAH IRRIGATION AND DRAINAGE CONGRESS 1917

LIFE MEMBERSHIP

Stewart, Scott P.....Provo, Utah

ANNUAL MEMBERSHIP

Adams, Charles.....Address not given
 Austin, Clarence.....Garland, Utah

Austin, E. N.	Salt Lake City, Utah
Brown, C. F.	Salt Lake City, Utah
Brown, George E.	North Ogden, Utah
Burk, C. W.	Hinckley, Utah
Beers, W. D.	Salt Lake City, Utah
Bingham, B. F.	Logan, Utah
Brihgam, B. F.	Logan, Utah
Cronquist, Olof.	Logan, Utah
Cook, Wm.	Hyde Park, Utah
Cardon, A. F.	Logan, Utah
Caldwell, R. E.	Salt Lake City, Utah
Call, R. V.	Address not given
Caine, John T., Jr.	Logan, Utah
Caine, John T. III	Logan, Utah
Cub River Irrigatalon Co., F. M. Stephenson, Secretary.	Richmond, Utah
Christiansen, J. B.	Nephi, Utah
Doremus, A. F.	Salt Lake City, Utah
Hulse, H. S.	Millville, Utah
Harris, F. S.	Logan, Utah
Hart, R. A.	Salt Lake City, Utah
Hanson, H. W.	Logan, Utah
Huntsville Irrigation Co., Geo. Aldous, Manager.	Huntsville, Utah
Israelsen, O. W.	Logan, Utah
Jerman, Reid	Payson, Utah
Judah, T. N.	Logan, Utah
Jarvis, O. W.	Logan, Utah
Kirkham, Jas. M.	Lehi, Utah
Keller, Karl F.	Payson, Utah
Lower Marion Canal Co., Daniel Lewis, President.	Address not given
McKay, David	Huntsville, Utah
McKay, D. D.	Ogden, Utah
Melville, J. Alex.	Salt Lake City, Utah
McPherson, A. M.	Delta, Utah
Nelson, Carl M.	Logan, Utah
Nielsen, Frederick	Murray, Utah
Nielson, W. I.	Salt Lake City, Utah
Nielsen, I. A.	Salt Lake City, Utah
Oveatt, George T.	Elmo, Utah
Provo Pressed Brick Co.	Provo, Utah
Peterson, N. P.	Salt Lake City, Utah
Potter, Jos.	Cleveland, Utah
Rasmussen, Amasa	Fairview, Utah
Smith, Jos.	Salt Lake City, Utah
Stewart, John	Address not given
Theobald, C. B.	Hinckley, Utah
Telford, S. R.	Richmond, Utah
Thompson, Edgar	Murray, Utah
Taylor, J. Edward	Salt Lake City, Utah
Walk, H. J.	Salt Lake City, Utah
Wilson, A. R.	Payson, Utah
Wheelon, J. C.	Garland, Utah
Winsor, L. M.	Logan, Utah
Wiser, S. F.	Lewiston, Utah
Woodbury, H. B.	Nephi, Utah
Wilson, T. R.	Huntsville, Utah
West Bench Irrigation Co., Paul Billings, President.	Address not given
Young, R. D.	Richfield, Utah

SECOND ANNUAL MEETING

The second annual meeting of the Utah Irrigation and Drainage Congress convened at the Utah Agricultural College, January 24, 1918. W. D. Beers, First Vice-President, presided.

Mr. Beers discussed the development of irrigation laws in Utah with special reference to the acquirement and control of water rights. He considered the significant doctrines which have been adhered to during various periods up to 1903, and then outlined the law of 1903 in detail and pointed out the fact that it had long been inoperative with respect to adjudication of rights and other phases.

W. R. Wallace, Chairman of the Utah Water Rights Commission, addressed the Congress on the Problems and Plans of the Commission. Mr. Wallace stated that the farmers were no doubt wondering why an ordinary business man should be made chairman of the Utah Water Rights Commission, pointing out that he was named as a member of the commission while away from the State in March, 1917, and that through the resignation of Mathonihah Thomas, the first chairman of the Commission, he, possibly due to his being the oldest member after the reorganization wherein L. R. Martineau, Jr., was elected, was then made chairman. Further Mr. Wallace reviewed the irrigation resources of the State of Utah, pointing out that of Utah's 54,000,000 acres of land about 1,000,000 or approximately 2 percent of the area was under irrigation at the present time. He urged the fact that by careful use of the water supply and prevention of the waste of water, thru lack of storage facilities and other factors, it would be possible tremendously to increase the present irrigated area and thus increase the wealth of the State and decrease the present taxing responsibility upon the individual irrigator. The State of Iowa boasts, said Mr. Wallace, that every 160 acres in the State is a farm. The difference in land problems, therefore, between Iowa and Utah were emphasized. Utah has large areas of non-irrigable land. Mr. Wallace made brief mention of the recent developments of a water supply for the city of New York with its 5,000,000 people, pointing out that a project had just been constructed at a cost of approximately \$200,000,000.00 or \$40.00 per capita; a very excessive cost for city water supply, and that at a similar rate it would cost Salt Lake City, with her 100,000 people, about \$4,000,000 to develop their water system. Further, Mr. Wallace commented on the system of land development in

UNIVERSITY OF ILLINOIS LIBRARY

JUN 3 1921

Australia as opposed to the plan in Utah wherein the government took considerable pains to supply the water at the time of need to make accurate distribution; and went farther, even to the extent of preparing land for irrigation, building houses, and upon sufficient evidence that individual farmers were responsible, placing them on ready-made farms. This, said he, probably never will be needed in Utah. Special attention was called to the development of irrigation by the U. S. Reclamation Service Projects, noting that the great problems of the Reclamation Service in recent years had been to obtain sufficient settlers to cultivate the lands under its various systems; whereas, this particular difficulty had not confronted the government in connection with its Strawberry Valley Project in Utah, since most of the lands irrigated by water stored in the Strawberry project reservoir were held by individuals before the time of Government development. Mr. Wallace asserted that the work of the Reclamation Service had been only partially successful, since it was found necessary frequently to make extension on the time in which farmers could make payment for their land, and that in fact, at the present time, since interest is not charged on the land and water right for which a period of 20 years is given to pay the principal, that it amounts to a subsidy by the government. Mr. Wallace asserted that the eastern people did not like to see money taken from the Federal Treasury to support the farmer on western land, and that in this thought he fully agreed that if it were impossible for the settler to make it pay, the project should not be developed.

In conclusion, Mr. Wallace pointed out the fact that the Water Rights Commission had considerable responsibility, and that up to the present time definite plans as to procedure were not yet crystalized. However, he assured the members of the Congress that the commission was fully in favor of protecting the rights of the citizens of Utah and that it would be endeavored to design a law which would make it possible for the Utah irrigator to profit by his own industry, and that if he found through application of modern methods of irrigation and through his industrious development of his farm, he could get along with less water than what his present rights permitted, he should be given the privilege to sell the surplus quantity of water and thus reap the benefits of his toil. (Applause). Mr. Wallace asserted that the present law did not permit a man to do this, but that as a decrease in the quantity of water necessary was made through improvement

of irrigation methods, the surplus water was declared reverted to the public. This, according to Mr. Wallace should be changed.

The Chairman, upon authorization by the Congress, appointed two committees, one on nominations and one on resolution. On the Nominations Committee, Geo. A. Slauch, Vernal; T. H. Humpherys, Logan; T. N. Judah, Logan; Jos. P. Welch, Hinckley; Edwin Southwick, Lehi; and N. P. Peterson, Salt Lake, were named. On Resolutions the following names were announced: Dr. John A. Widtsoe, Chairman, Salt Lake; J. W. Paxman, Nephi; James Meikel, Logan; W. W. Owens, Richfield; D. D. McKay, Huntsville; H. A. Christensen, Beaver; L. R. Martineau, Jr., Salt Lake.

By the consent of the Congress the offices of Secretary and Treasurer were combined so that the two positions would be held by one man only.

The last speaker at the morning meeting was Mr. L. R. Martineau, Jr., who discussed the subject, "Why the Water Rights Commission and the Farmer Should Cooperate," pointing out the important periods in recent irrigation development with special reference to the appalling cost of litigation over water rights in recent years in the State of Utah. Mr. Martineau urged that a more consistent means of determining water rights must be devised wherein a whole stream system may be handled at one time, in order to avoid continuous unnecessarily expensive litigation between individual parties. Further, such system should also include the State in every water suit in order that the public might be properly represented, so that once determined, the farmer could look to the State for protection of his established and recorded water rights.

AFTERNOON MEETING, JANUARY 24, 1918

The afternoon meeting was begun by several musical numbers from the College orchestra and Glee Club under the direction of Prof. C. R. Johnson. The main features of the afternoon program were addresses by Dr. John A. Widtsoe, President of the University of Utah, Dr. George Thomas, of the University, and Prof. Wm. Peterson of the Agricultural College. The talks of Dr. Widtsoe and Dr. Thomas follow in part.

WHAT CAN UTAH IRRIGATORS CONTRIBUTE TO THE WORLD'S AGRICULTURAL PROGRESS

By DR. JOHN A. WIDTSOE

My friends, it seems very natural to be in this hall and speak from this platform. I think I enjoy it much more owing to the fact that many years of my life I have spent in the service of this institution. I am glad, however, to see that things are prospering here at the Agricultural College. I am glad for this, and I hope the time may never come in Utah when the people of this State will fail to understand the vitality and usefulness of this institution.

I have been asked by someone, I think the Secretary, to speak to you this afternoon on "What Can Utah Irrigators Contribute to the World's Agricultural Progress." This topic was not of my choosing. It was assigned to me. I wondered if the Secretary had the same feeling toward my speech as my wife had. I appealed to my wife, who is supposed to help in all emergencies, on what I should speak about. She said, "Speak about five minutes." I suppose the Secretary expects me to speak about five minutes.

But, perhaps, there is no joke in this subject. When the people entered these valleys in 1847, let it be noticed by all who love this State that there was no systematic rational irrigation practice on this continent and very little in other lands. The Catholic missionaries had come to this country and these missionaries had established small irrigation systems, just big enough to supply the gardens around the missions. But the work of the Catholics, much as we admire it, and much as we praise it, did not do much toward furthering irrigation practice on this continent. We of this State must not be contented with doing the ordinary irrigation work. We must be the leaders. And if it be true that we are not leaders today as we were 50 years ago, we must make up our minds again to attain the place in irrigation that we held in 1847. We of Utah have known irrigation practice in its highest form under the highest civilization, and by its most powerful influences.

And may I say to you that the day will come when the rainless districts of the world are going to be the salvation of the world. The earlier civilization and our modern civilization have erroneously believed that those countries most valuable to mankind was where rainfall was heavy. We have looked upon rainless districts of the world as of little value.

People are crowded together in the cities of the old world, huddled together like cattle or like sheep; living not much better than the animals on which we feed.

You know more than one-half of the surface of the earth lies under low rainfall. And upon this one-half, lies the future salvation of the world. And just now, when we are in war, I imagine a great many people look toward these great areas. We must make use of the great arid regions of the world.

Now in what way are the people of this State at this time, the most vital time in the history of the earth, going to set an example to the world that will help her? We are going to do this by proving to the world that the blood of the pioneers still flows in the sons of the pioneers. When people in the great Salt Lake Valley, the pioneers of the State, solved their problems, they left problems equally difficult. Are

we made of the same stuff, or are we content to go on and say that the work is done. There is yet great work to be done in conserving the waste waters. Shall we permit this work to remain undone?

We have the great rivers that contribute to the Colorado, the Grand, Green, and the Duchesne flowing through our State; all these rivers filled with water and this water carries large quantities of life-giving substances.

Let's take one of these rivers and tame and use it for irrigation purposes and others will see it, and they in turn will show other countries and they in turn will show the world and our agriculture will be advanced.

What less may we do by way of advancing the agricultural interests of the world. Seventy years, last year, we have lived under an irrigated condition in an irrigated commonwealth. We have learned a great many things. We have done big things and we have seen a good many things. This State has provided means whereby a great body of irrigation literature has been developed. The government has done much, other states have done much,—all in all the United States and Utah have brought forth a lot of new practices.

I would like to say to you that the one thing of greatest importance is that provision be made for the teaching of the fundamentals of irrigation practice so that our many brilliant young men may carry this work forward.

Now I think the five minutes have just about passed. I verily believe that if Germany had been an irrigated State; if throughout the Empire of Germany, had passed great irrigation canals with main laterals and sub-laterals; if the Germans had been brought up under the irrigation ditch as we have, it would have been impossible to erect in Germany the present autocracy filled with human hatred.

Great men are being reared under the ditch. I would to heaven that all of this world could be under the ditch. The welfare and safety of the world would be much more insured under the ditch than anywhere I know of.

God grant that the day may be near at hand when man learns wisely to make use of irrigation water, this greatest of natural resource and that the training, the development, and the improvement that we get under the ditch will be increased in our sons and our daughters that they may be the leaders in making the world a better and more holy place; what we all want it to be.

**"THE GROWTH OF FUNDAMENTAL DOCTRINES UPON
WHICH WESTERN WATER RIGHTS REST, WITH
SPECIAL REFERENCE TO WATER
RIGHTS IN UTAH"**

By DR. GEORGE THOMAS

Dr. Thomas reviewed the early irrigation operations of the Spanish Mission fathers and others in Southern California, Arizona, and New Mexico. He showed that irrigation institutions were then developed according to the immediate needs which confronted the people and not according to precedents from older countries. As typical of the early irrigation practices, and of the basis of water rights, he cited the following from *Clough v. Wing*, (2 Arizona 371) and (17 Pacific 453).

"And the right to appropriate and use water for irrigation has been recognized longer than history, and since earlier times than tradition. Evidences of it are to be found all over Arizona and New Mexico in the ancient canals of a prehistoric people, who once composed a dense and highly civilized population. These canals are now plainly marked, and some modern canals follow the track and use the work of this forgotten people. The native tribes, the Pimas and Papagos, and other Pueblo Indians, now, as they for generations have done, appropriate and use the waters of these streams in husbandry, and sacredly recognize the rights acquired by long use, and no right of a riparian owner is thought of. The only right in water is found in the right to conduct the same through their canals to their fields, there to use the same in irrigation. The same was found to prevail in Mexico among the Aztecs, the Toltecs, the Vaquits, and other tribes at the time of the conquest, and remained undisturbed in the jurisprudence of that country until now."

As further evidence of the recognition that special doctrines must be developed to meet the needs of the arid west, Dr. Thomas called attention to the essentials of a case decided as early as 1855 in California, the following extract from which clearly shows the idea conveyed.

"Courts are bound to take notice of the political and social condition of the country which they judicially rule. In this State the larger part of the territory consists of mineral lands, nearly the whole of which are the property of the public. No right of intent of disposition of these lands has been shown either by the United States or the State governments, and with the exception of certain State regulations, very limited in their character, a system has been permitted to grow up by voluntary occupation of the mineral region that has been tacitly assented to by the one government and heartily encouraged by the expressed legislative policy of the other. If there are, as must be admitted, many things connected with this system, which are crude and undigested, and subject to fluctuation and dispute, there are still some which a universal sense of necessity and propriety have so firmly fixed that they have come to be looked upon as having the force and effect of *res judicata*. Among these the most important are the rights of the miners to be protected in the possession of their selected localities, and the rights of those who,

by prior appropriation, have taken the waters from their natural beds, and by costly artificial works have conducted them for miles over mountains and ravines, to supply the necessities of gold diggers, and without which the most important interests of the mineral region would remain without development. So fully recognized have become these rights, that, without any specific legislation conferring or confirming them, they are alluded to and spoken of in various acts of the legislature in the same manner as if they were rights which had been vested by the most distinct expression of the will of the lawmakers. . . . This simply goes to prove what is the purpose of the argument, that however much the policy of the State, as indicated by her legislation, has conferred the privilege to work the mines, it has equally conferred the right to divert the streams from their natural channels, and as these two rights stand upon an equal footing, when they conflict, they must be decided by the fact of priority, upon the maxim of equity, 'Qui prior est in tempore, potior est in jure.' Irwin v. Phillips, (5 Cal. 140, 1855).

The speaker then outlined further the development of the doctrine in the various western states and territories which was finally crystalized by the first Federal legislation which is now the famous act of 1866 in which Congress said:

"Whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing, or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws and decisions of courts, the possessors and owners of such vested rights shall be maintained and protected in the same; and the right of way for the construction of ditches and canals for the purposes herein specified is acknowledged and confirmed; but whenever any person, in the construction of any ditch or canal, injures or damages the possession of any settler on the public domain, the party committing such injury or damage shall be liable to the party injured for such injury or damage."

In further explaining the development of the doctrine of prior appropriation and the Federal legislation of 1866, Dr. Thomas called attention to an early belief that priority of appropriation would tend to give individuals who first settled on the stream a complete monopoly of a valuable natural resource. That this idea was in error, however, was clearly shown in pointing out that the courts and the public generally maintained that "the basis, the measure, and the limit" of a right obtained by priority of possession was "beneficial use" under reasonable farming conditions and further that reasonable diligence was always insisted upon in the development of irrigation projects wherein a right to the diversion of water was granted by the State. It was clearly shown that water-hogging could not exist under the early development of prior appropriation when based on beneficial use.

Dr. Thomas discussed the development of irrigation institutions early during the period of Utah irrigation and pointed out that, at the very outset Utah devised a plan (1) for granting rights to the use of streams under public supervision, and (2) for protecting the rights of the public. The speaker showed that in September, 1850, when Congress provided for a territorial legislature, the important questions of supervising the natural resources of the territory began to be given

careful consideration, and that in the first territorial legislature, which met the following winter, the responsibilities of granting rights to timber lands, to roadways, and to waters of the territory were delegated to the county court, a body which was truly administrative, consisting of what are now termed county commissioners, with the addition of a probate judge. The territory, however, reserved a right to grant special privileges on certain streams and thereby maintained a somewhat dual control of natural resources until 1867 when Congress prohibited territorial grants of a special nature. Several examples of grants by the administrative county court were given, among which were a right granted to Pulsipher, et al., in 1852, one to F. Little, et al., in 1859, for waters from the Jordan River, and one to Gardener, Miller, Falk, et al., to an amount of water equal to two-fifths of the Jordan River, provided the construction work for the diversion was completed by January, 1853. The following direct quotation from the Utah law of 1852 indicates the type of supervisory power exerted over natural resource, including water, at that early date.

"That the inhabitants of the settlement of Dry Creek in Utah County are hereby authorized and allowed to take out at some convenient point, the waters of American Creek, and use the same for their benefit, provided that no more than one-third part of said water shall be so taken for the use of said settlement on Dry Creek."

The speaker pointed out the distinct changes which occurred in the Utah irrigation law in 1880, at which time the probate judge was dropped from the administrative county board and the provisions for this public board granting rights to the use of water were also eliminated. This obviously had the effect of leaving water rights to be acquired under no public control whatsoever. When troubles arose due to conflicting interests the county administrative body was expected to hear claims, settle disputes, and determine vested rights. The law also provided that the board should appoint commissioners to distribute water. The early principle that water was public property and in order to obtain a right to it such right must be confirmed by its owner, the public, was abandoned. The provision that the county selectman should hear disputes and determine rights was early declared unconstitutional by a district court, since it granted judicial powers to an administrative board which were not conferred by the territorial organic law. The question was not passed on by the supreme court. After the law, providing that the county selectmen should determine water rights, was declared unconstitutional and void, Utah experienced a rather dormant period in irrigation legislation. The public was no longer represented in appropriations of water and individuals developed the attitude that water was their personal property and that it was purely their privilege to use it or waste it as they desired.

The speaker reviewed the conditions confronting the State of Utah during 1896 at the constitutional convention. While an efficient system of public administration of water rights was presented for inclusion in the State constitution, it was rejected and the constitution was adopted with no mention of water rights, because of an inherent fear of the people at that particular time that any system which would centralize authority in public officials which were not of their choosing would be likely to curtail their rights and seriously interfere with their economic progress.

After reviewing the development of irrigation law in Utah, Dr. Thomas returned to a further consideration of the growth of fundamental and basic doctrines as based on court decisions and referred especially to the States of Utah, Colorado, Wyoming, and California. "It is generally conceded," said Dr. Thomas, "that Colorado, in *Coffin v. Lefthand Ditch Company*, (6 Colorado, 443) decided in 1882 was first to say that the riparian right doctrine, that is, the right of the owner of land adjoining streams to have the water flow undiminished in quantity and unpolluted in quality, was not applicable to the intermountain region, and thereby abrogated doctrine of riparian rights and instituted the so-called doctrine of prior appropriation. However, the Utah courts in reality, even at an earlier date, set aside completely the doctrine of riparian rights and instituted the far more suitable doctrine of prior appropriation based on 'beneficial use'." The language used in the Colorado court is, however, very significant, as pointing out the principles of prior appropriation upon which the most economic development of arid lands is absolutely dependent. The words of the court are as follows:

"We conclude then that the common-law doctrine giving the riparian owner a right to the flow of water in its natural channel upon and over his lands, even though he makes no beneficial use thereof, is inapplicable to Colorado. Imperative necessity, unknown to the countries which gave it birth, compels the recognition of another doctrine in conflict therewith. And we hold that, in the absence of express statutes to the contrary, the first appropriator of water from a natural stream for a beneficial purpose has, with the qualifications contained in the constitution, a prior right thereto to the extent of such appropriation."

As opposed to this logical doctrine, Dr. Thomas then described more fully the so-called doctrine of riparian rights, pointing out that such rights are inherent in the land, do not depend on use, and therefore do not begin with use nor cease with disuse. The celebrated case of *Lux v. Haggin* decided by a divided court in California during the late 70's was reviewed to show that the riparian doctrine, even as modified by *Lux v. Haggin* is entirely unsuited to western conditions and that, moreover, Utah should feel fortunate in not having this doctrine to contend with. The language used in the case of *Lux v. Haggin* follows:

"By the common law the right of the riparian proprietor to the flow of the stream is inseparably annexed to the soil and passes with it, not as an easement of appurtenance, but as part and parcel of it. Use does not create the right, and disuse cannot destroy nor suspend it. The right in each extends to the natural and usual flow of all the water, unless where the quantity has been diminished as a consequence of the reasonable application of it by other riparian owners for purposes hereafter to be mentioned.

"By our law the riparian proprietors are entitled to a reasonable use of the waters of the stream for the purpose of irrigation. What is such reasonable use is a question of fact, and depends upon the circumstances appearing in each particular case.

"The right of enjoyment of this flow, without disturbance or interruption by any other appropriator is pure 'jure natura' and is an incident of the property in the land, not an appurtenant to it

like the right he has to enjoy the soil, itself in its natural state, and unaffected by the notion or act of a neighboring land owner. It is an inseparable incident to the ownership of the land made by an inflexible rule of law and absolute and fixed rights, and can only be lost by grant or by twenty years' adverse possession." (69 Cal. 255).

The seriousness of the principle established in the case of *Lux v. Haggin* by the California supreme court can only be appreciated by a careful study of the wastefulness which is permitted in the use of so valuable an asset as irrigation water, in those states which now recognize this rule. This wastefulness is typified in a very recent California case, that of *Miller and Lux v. Madera Canal Company* (155 Cal. 59) decided in 1909. *Miller and Lux* were owners of large areas of grazing land in the low-lying section adjoining the junction point of the San Joaquin and Lower Fresno Rivers. The Madera Canal Company was desirous of storing flood waters for the irrigation of high-lying profitable fruit land, and *Miller and Lux*, as owners of large herds of cattle, objected on the ground that the flood waters carried with them valuable fertilizing materials which were each year deposited upon their lands. The canal company argues that since it desired to store only the flood waters which could not be considered a part of the natural flow to which riparian owners were entitled, that the diversion should be permitted and furthermore that such storage would be far more beneficial to society than having such flood waters inundate lands during the winter, a very wasteful use. The court refused to accept the argument of the canal company in the following language:

"What the riparian proprietor is entitled to as against non-riparian takers is the ordinary and usual flow of the stream. There is no good reason for saying that the greatly increased flow following the annually-recurring fall of rain and melting of snow in the region about the head of the stream is any less usual or ordinary than the much diminished flow which comes after the rains and the melted snows have run off.

"The doctrine that a riparian owner is limited to a reasonable use of the water applies only as between different riparian proprietors. As against an appropriator who seeks to divert water to non-riparian lands, the riparian owner is entitled to restrain any diversion which will deprive him of the customary flow of water which is or may be beneficial to his land. He is not limited by any measure of reasonableness." (155 Cal. 57).

The speaker very much regretted the fact that many of the arid states were confronted with so serious a doctrine with respect to water rights. He urged the value of beneficial use, or more properly, economic use, as "the basis, the measure, and the limit of a water right." He further emphasized the absolute need of every state being represented in water right litigation, in order that the rights of future comers, as well as those of the present users, may adequately be protected. He quoted freely from the opinions of Mr. A. E. Chandler, President of the California Water Rights Commission and others with respect to the inherent difficulties in overcoming court decisions such as that of *Miller and Lux v. Madera Canal Company*.

He quoted also the constitutions of Wyoming and Colorado, with respect to the provisions concerning water rights. In 1890 Wyoming

included in its constitution, article 8, Sections 1 to 5, the following provision:

"The waters of all natural streams, springs, lakes, or other collections of still waters within the boundaries of the state are hereby declared to be the property of the State."

The speaker then outlined further that by constitutional provision a board consisting of the state engineer and four superintendents of water divisions, had the responsibility of determining water rights in the State of Wyoming, subject to the review of the courts, and that after rights were determined, the board had power to distribute water according to established rights. The fact that the State of Wyoming is represented in all water right litigation was emphasized as very desirable.

The following provision from the Colorado constitution, Article 15, Section 5 was given.

"Water of every natural stream not heretofore appropriated within the State of Colorado is hereby declared to be the property of the public and the same is dedicated to the use of the people of the State, subject to appropriation as hereinafter provided."

Dr. Thomas pointed out the fact that the weakness of the Colorado system is lack of public representation in water right determination, as a result of which many decrees to excessive amounts of water have been written giving, for example, as much as 33 cubic feet per second for 120 acres.

The speaker then described the gradual development in the courts of the recognition of the importance of basing rights to the use of water on "beneficial" or "economic" use. To substantiate this view he cited the following extracts from courts in the various states, which clearly indicate that rights to the use of water must be based on continuous, beneficial use. The following extracts were given:

Oregon, in the case of *Andres v. Donnelly*, (116 Pacific, 569) said: "Before the country was so thickly settled as it is now, the practice for the appropriation of water to keep all you get and get all you can was in many cases tolerated. But yielding to reason and justice to all, the authorities have established a different rule. We conceive it to be the law, as modified by statute, that the right of a prior appropriator is paramount, but the right is limited to such an amount of water as is reasonably necessary for such useful purpose and project as may be barely within contemplation at the time the appropriation is made. (1911)."

Huston vs. Bydee, 17, Oregon, —. "A prior appropriator has the right to use the water to the full extent of his appropriation when the condition of his premises is such as to require the use of water for his purposes; but he has no right to waste it, to use it extravagantly or imprudently so as to injure the rights of others."

From Nevada, the following quotation was given:

"But whatever he may be irrigating, he is entitled to the amount he economically and reasonably used, and when he has that, he cannot prevent others from using the surplus." *Roder vs. Stein* 23, Nevada, 92.

From the State of Idaho, the following quotation was given:

Farmers, etc. vs. Fiver Side Irrigation District 16 Idaho 52. "Economy must be required and demanded in the use of and application of water. Water users should not be allowed an excessive quantity of water to compensate for and counterbalance their neglect or indolence for the successful and economical application of the water. One farmer, although he has a superior water right, should not be allowed to waste enough water in irrigation of his land to supply both him and his neighbor, simply because his land is not adequately prepared for the economical application of water."

From South Dakota and Colorado the following extracts are given:

South Dakota. Stranger vs. Thorpe. "An appropriation of water by the owner of land by means of a ditch is not measured by the capacity of the ditch through which the appropriation is made, but is limited to such quantity not exceeding the capacity of the ditch as the appropriator may put to a useful purpose."

In Woody vs. Sargen, the court made the following statement: "In order to constitute an appropriation of water there must not only be a diversion of the water from the stream and a carrying of it to the place of use, but it must be beneficially applied and the measure of the appropriation does not depend alone upon the amount diverted and carried, but the amount which is applied to a beneficial use must also be considered. For instance in the case of New Mercer Ditch Company vs. Armstrong, it was determined by the decree that the ditch had a carrying capacity of about 33 cubic feet per second. It was constructed to irrigate 120 acres of land and it was determined tha the appropriator was entitled to only so much water as he could beneficially apply on the land. Woody v. Sargent, Colorado."

From Utah, in the case of Manning et al vs. Price et al, the court said: "Speaking of the right to a quantity of the water, the right only vests to the extent of the necessity." 1898.

In order to show further that Utah is fundamentally in agreement with the other States, from which quotations have been made above. to the effect that water is the property of the public and that individuals may obtain rights to its use, which are based on, and limited by "beneficial or economic use," Dr. Thomas pointed out that the legislature of 1903 specifically declared that "the water of all streams and other sources in this state, whether flowing above or under the ground, in known or defined channels, is hereby declared to be the property of the public, subject to all existing rights to the use thereof." (Laws of Utah 1903, page 101).

Moreover, Dr. Thomas asserted that the courts' decision had fairly crystalized the idea that water must be economically used in order to maintain righst thereto. As evidence of this fact, he cited the case of Nephi Irrigation Company v. Vickers, wherein the Supreme Court ordered the district court to determine to how much water Vickers was entitled in order to irrigate 31 acres of land. (15, Utah 374).

Again in 1910, the supreme court in speaking of water appropriation says: "His appropriation will bem easured by the quantity of water actually used for proposed beneficial purpose (Sowards v.

Meagler, 37, Utah, 225, 1910) and further in 1911, the supreme court said, "He is limited to the amount he applies to beneficial use, etc." At the same time the court further specifically declared the fact that waste must be prohibited in the following language: "We are likewise clear that in this arid region no water that is thought to be applied to a beneficial purpose, should be permitted to go to waste, unless it is clearly made to appear that it cannot be so applied without interfering with the prior rights of other users. If, however, such prior rights can be preserved by merely changing the methods or means through which the water of prior users is applied, then the methods or means used by them should be changed if they can be without interfering with a particular use so as to permit the use of the surplus and unappropriated water by the subsequent applicant therefor."

Dr. Thomas concluded his address by emphatically urging the necessity of the State of Utah going back in practice as well as in theory to the original doctrine which had been adhered to by the pioneers; namely, public ownership of the water supply and also to maintaining of a supervisory board which should be given responsibilities of granting rights to the use of water, of determining vested rights, and more particularly, of supervising the distribution of the State's water supply, according to established rights, in order that the present wasteful litigation might be very largely eliminated, and further that the present chaos and lack of information concerning water rights in Utah may soon be removed.

The Secretary's announcement that the officers had elected Dr. John A. Widtsoe as the first honorary member of the Congress brought a hearty applause. The following resolutions submitted by the Committee were unanimously adopted:

RESOLUTIONS PASSED BY THE UTAH IRRIGATION AND DRAINAGE CONGRESS—JANUARY, 1918

Your committee on Resolutions submits for your consideration the following:

(1) WHEREAS, The Utah Agricultural College, through the Extension Division, has courteously extended the opportunity to hold the meetings of the Congress in connection with the excellent work of the annual Round-up,

NOW, THEREFORE, BE IT RESOLVED that the hearty thanks and appreciation of this congress be voted for the hospitable reception and generous aid given by the College and its faculty.

(2) WHEREAS, during a number of years past and at present the Experiment Station of the Utah Agricultural College has been and is engaged in the study of the fundamental principles underlying sound irrigation practice, and

WHEREAS, that work has not only given Utah a name in the forefront of irrigation states, but also has given the farmers and irrigators of Utah knowledge of incalculable value,

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress express publicly its appreciation of the Experiment Station's many splendid contributions in irrigation research and grateful acknowledgment of the steadfast encouragement, information and help to the members of this congress, and to farmers generally throughout the State, which it has rendered.

(3) WHEREAS, there are still many perplexing problems confronting the irrigators of Utah and those of her neighboring states, and, whereas, much more knowledge of the relations of soils, crops and irrigation water must be obtained to form the basis of the solution of these problems, and

WHEREAS, there is at present especially urgent need of conducting, under the various soil, crop, and climatic conditions in other typical irrigated sections of Utah, investigations concerning crops, soils and water similar to those which have been conducted on the Experiment Station Farm at Logan,

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress urge the State to make possible by liberal appropriations, a continuation of the studies in irrigation above mentioned and an extension of such studies at an early date to typical farms in each of the important river systems of Utah, especially as relative to soil and crop factors upon which must depend the further development of rational and economical use of water.

(4) WHEREAS, the great body of truth relating to irrigation science and practice unfolded by the Utah Experiment Station, by other Experiment Stations and by the United States Department of Agriculture, has not been made fully available for the irrigators of the State,

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress plan and carry through an active campaign for the spread of all such information; that the College Extension Division be requested to take active supervision of this work; that the assistance of the farm bureaus, the "Utah Farmer" and the various irrigation companies be enlisted in this work, as well as such other energetic means as will give each farmer a practical knowledge of the best irrigation methods.

(5) WHEREAS, we have been called into the great war in defense of justice and humanity and have pledged our every energy and resource in this great cause, and

WHEREAS, the prevention of all waste is an essential factor in this struggle, and we have had emphasized anew the responsibility of the farmer as the food producer of the nation,

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress, individually and as a body, pledge itself and its members to assist in the conservation of irrigation water generally, and especially the flood waters of our streams which have heretofore been largely wasted and lost.

(6) WHEREAS, it is apparent that the legal definition of "beneficial use" of water has not always limited the amount of water to the minimum amount which might be dictated by the best irrigation practice.

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress co-operate with like organizations of other states, and that to this end a standing committee on inter-state affiliation be appointed by the President of this Congress and the President is hereby authorized and directed to use such other and further means as may be necessary in the premises.

WHEREAS, the success of irrigation throughout the State depends on the co-operation of the irrigators with each other and with the State and National Governments,

NOW, THEREFORE, BE IT RESOLVED that the Utah Irrigation and Drainage Congress pledge for itself and its members its whole-hearted support and co-operation to State and National Governments, and at this time particularly pledge its earnest assistance to the Water Rights Commission of Utah.

The Congress unanimously elected as officers the ensuing year the following men, whose names were submitted by the Committee on Nominations:

Name	Address	Office
John A. Widtsoe—Salt Lake City.....		President
R. A. Hart—Salt Lake City.....		First Vice-President
H. S. Kleinschmidt—Salt Lake.....		Second Vice-President
Thomas E. McKay—Huntsville.....		Third Vice-President
O. W. Israelsen—Logan.....		Secretary-Treasurer

DIRECTORS—JUDICIAL DISTRICTS

C. M. Nelson—Logan.....	First District
W. S. Hanson—Collinston.....	Second District
Francis Kirkham—Salt Lake City.....	Third District
George A. Slauch—Vernal.....	Fourth District
W. F. Pratt—Hinckley.....	Fifth District
L. W. Jones—Monroe.....	Sixth District
A. H. Marshall—Wellington.....	Seventh District

CONGRESSIONAL DISTRICTS

R. E. Caldwell—Salt Lake City.....	First District
H. A. Christensen—Beaver.....	Second District

STATE AT LARGE

L. R. Martineau, Jr.....	Salt Lake City
Joseph R. Murdock.....	Heber

**MEMBERS OF UTAH IRRIGATION AND DRAINAGE
CONGRESS, 1918**

LIFE MEMBERS

Name	Address
Doremus, A. F.....	Salt Lake City, Utah
Hooper Irrigation Company.....	Hooper, Utah
Millville Irrigation Company, by J. A. Hovey.....	Millville, Utah
Stewart, Scott P.....	Provo, Utah

ANNUAL MEMBERS

Name	Address
Brown, C. F.....	Salt Lake City, Utah
Burnham, P. E.....	Woods Cross, Utah
Brookie, F. M.....	Salt Lake City, Utah
Carter, B. E.....	Logan, Utah
Christensen, H. A.....	Beaver, Utah
Corinne Concrete Tile Co., by L. C. Howard.....	Corinne, Utah
Harris, F. S.....	Logan, Utah
Hart, R. A.....	Salt Lake City, Utah
Israelsen, O. W.....	Logan, Utah
Judah, T. N.....	Logan, Utah
Kleinschmidt, H. S.....	Salt Lake City, Utah
Melville, J. A.....	Salt Lake City, Utah
McKay, T. E.....	Huntsville, Utah
Nelson, C. M.....	Logan, Utah
Pond, Charles.....	Lewiston, Utah
Pond, Brigham.....	Lewiston, Utah
Smithfield Brick & Tile Company.....	Smithfield, Utah
Stookey, A. J.....	
Williams, D. H.....	Glover, Utah
Wheelon, J. C.....	Garland, Utah

THIRD ANNUAL MEETINGS OF THE UTAH IRRIGATION AND DRAINAGE CONGRESS

Federal Building, Ogden, Utah*

President John A. Widtsoe opened the Third Annual meeting of the Utah Irrigation and Drainage Congress by introducing Mayor Frank Francis of Ogden. Mayor Francis welcomed the members of the Congress to the city of Ogden and spoke of the great opportunities awaiting the builders of the West. The Mayor said further:

"I see that you have coupled irrigation with drainage and that reminds me of an occurrence in my office yesterday. A stranger came in and I said, 'Where is your home?' He said, 'Babylon,' and I asked 'Where is Babylon?' He said, 'Today it is a waste, the district as a whole is a waste.' And then he said, 'Babylon, the famous city of old is no more,' and that took me back to one day when I read of the collapsed irrigation district of Mesopotamia. The one I bring to memory is 250 miles long. Euphrates enters Bagdad and historians have not agreed as to what happened to that part of Mesopotamia that the cradle of civilization at that time should have almost disappeared, but some of our writers claim there was no art of drainage in those early days. The irrigation waters brought to the surface alkali salts, and the people were forced away from their home. I am therefore glad that you have seen the wisdom of coupling irrigation and drainage.

"When I first came into this State, I went through the town of Corinne. It was a beautiful stretch of country, in the spring of the year. I visited there a few years ago and there was nothing but alkali and salt grass. I have seen many investments there disappear as the alkali and salt came into the fields. Since

*Due to the fact that one of the court reporters who took stenographic notes of the proceedings during the Third annual meetings failed to submit transcript of his notes, despite frequent pleading and urging of the secretary, the discussions which followed some of the papers are unfortunately not included in the proceedings. Had not the reporter frequently promised that the transcript would shortly be submitted, the Secretary would have attempted mandatory means of obtaining it. Finally, however, after many months delay it was decided to publish the original papers, despite the loss of the valuable discussions which followed them.

then you have started the great drainage there. You are a God-send to that district, and now, as I understand, you are coming into this county and with your plan of irrigation and drainage and I feel that you are about to do for us a wonderful work, and because of the promise you give to us you are not only welcome, but thrice welcome, and Ogden greets you and offers you the very best we have. I thank you."

The members of the congress selected the following committee on nominations: M. A. Abbott, W. P. Thomas, J. W. Nielsen, D. D. McKay, Chas. M. Holten, J. F. Parker, J. L. Rhead.

Papers and discussions of this session follow in order.

IRRIGATION RECONSTRUCTION IN WEBER COUNTY, UTAH

By SAMUEL FORTIER

Chief Irrigation Division, Bureau of Public Roads,
U. S. Department of Agriculture.

In going up a steep trail, one frequently pauses to look back over the way he has come. From the vantage ground of this beautiful city, we have called a halt for a similar purpose. We wish to look back over a community which began its struggle with desert conditions while Abe Lincoln was practising law, trace its progress thus far, and most important of all, try to shape its course in the future so that an abundant measure of success will eventually crown its efforts. A glance at the past and a consideration of the present may give us clearer views of the greater achievements which it is hoped will come with future years.

In 1848, a few of the early Utah pioneers diverted water from Ogden River within a mile of where we are now assembled in order to obtain water to irrigate their grain and potatoes. Two years later, the gold diggers of California were greatly troubled about how to secure a supply of fresh vegetables. Few imagined that any produce of that kind could be grown on the banks of the Sacramento or its tributaries, and some of the more hopeful congratulated themselves that the Hawaiian Islands then called the "Sandwich Islands", were so near since vegetables might be brought by boat from these islands to supply the miners. This glimpse of an earlier day shows that the people of Utah were the first of the Anglo-Saxon race to demonstrate the fertility of arid soils when moistened with water. It was not long, however, until others learned the lesson, not only in California but in the other territories crossed by the Overland Trail. The water of nearby streams was conducted to river bottom lands to raise food for the settlers and fodder for the pony express. The first plough-share turned up the fertile soil of the Gallatin Valley, Mont., in 1864, and in 1870 Horace Greeley founded his colony

in Northern Colorado. That now famous district, the citrus groves of California, had a still later start. These brief references to localities where irrigation was first practiced, and a few more that might be named, comprise the greater part of American irrigation development for the first 25 years. It was not until the beginning of the eighties that irrigation attracted much public notice. Then followed a mad rush on the part of corporations to appropriate water, build canals and attain independence in a few years by the sale of water rights and the collection of water rentals. The hard times of the early nineties which followed this too rapid development not only greatly retarded construction work of all kinds but caused in many enterprises a somewhat radical change of plan. Many promising undertakings had to be abandoned for lack of funds, receivers were appointed for canal companies and foreign investors were longing for returns which never came.

From the time water was first diverted from the streams of the Wasatch Mountains until the close of the 19th century, Utah won an enviable position among the states of the west as a pioneer and leader in irrigation. In appreciation of what the state had accomplished, the first session of the National Irrigation Congress was held in Salt Lake City in 1891, and leaders from all over the west who attended that congress were desirous of securing first hand information in regard to the principles, customs and practises underlying Utah's success in handling its land and water resources.

It was in this state that cooperation in irrigation had its origin, and every state west of the Missouri is indebted to the pioneers of Utah for having so successfully demonstrated how men of all nationalities can plan and work for the good of the community. Mutual assistance, cooperation and copartnerships were the foundation stones upon which the commonwealth was founded. In their efforts to make desert lands productive, the pioneers of Utah evolved new ways of doing things and some of these early customs and methods have become the leading features of American irrigation practice.

It is always a pleasure to give praise where praise is due. Cooperation has become so common and so essential to land reclamation throughout the West that we are apt to overlook its humble origin. We do not often give credit to the men who worked out and put into successful operation a system of cooperation by which the poorest farmer can have a share in the canal which conveys water to his farm, in the dairy which churns the milk of his cows, in the cannery which preserves his fruits and vegetables, and in the association which markets his crops. Candor compels me to admit, however, that in the irrigation development which has taken place during the 20th century, Utah has not held her own with some of her sister states. Much of the prestige of former days has been lost. Other states no longer copy its laws or its methods. Models of canal systems, irrigation structures, plans of water delivery and the accurate division of water are more likely to be found in other western states. There can therefore be no more important or more urgent measures to consider at this convention than the restoration of irrigation in Utah to its former commanding position, and this brings me to the topic which I was asked to discuss, viz: Irrigation Reconstruction in Weber County.

My familiarity with irrigation leads me to conclude that the reconstruction of irrigation systems is not only of the greatest importance but that it is the one big problem confronting most of the older irrigated districts. The ditches built in pioneer days have as a rule served their

purpose and should be abandoned altogether or merged into larger, better designed and more efficient systems. For periods ranging all the way from 50 to 70 years, communities in such states as California, Colorado, Montana and Utah have utilized the summer flow of streams for the watering of their farms. Bottom lands adjacent to streams were first brought under ditch and from these crude beginnings other higher lands more distant from the source of supply were reclaimed. In this haphazard fashion, ditch after ditch has been taken out without much thought being given to the final outcome or to what confusion such a course would eventually lead. The object sought in nearly every case was to get water at the least possible cost without regard to the efficiency of the system or the waste of water which such practise might entail. It was seldom that any river and its tributary watershed was carefully studied and a system of diversion canals planned in such a way as to utilize the flow to the best advantage, with a view of getting the largest possible service from this valuable natural asset. Grab rule was allowed to predominate. It was a mad rush on the part of settlers to tap the stream first and thus secure the advantage of priority regardless of how or where the ditch was located or whether the diversion of a certain volume of water would interfere with or jeopardize the prior rights of others. Over half a century of this kind of development has resulted in a state of affairs which on account of the complications and the many vested interests involved, is extremely difficult to adjust in a manner satisfactory to all concerned. At the same time the obstacles to be overcome should not deter public spirited men from making the attempt, for if conditions are allowed to drift on as they are at present, there can be little progress made in farming by irrigation.

The situation at present in many of the older irrigated valleys of the West may be briefly stated as follows: The number of independent main canals is out of all proportion to the area of land irrigated. One frequently finds as many as five canal systems conveying and distributing water to a relatively small acreage which one system would serve more effectively and at less cost. Each canal is built in earth and the loss of water by absorption and seepage in so many channels forms a large part of the amount of water admitted through the intake. Each system has likewise its organization to maintain with a full quota of directors, superintendent and water masters, and not infrequently an engineer and attorney. Perhaps the gravest objection lies in the fact that so many separate and independent companies divert water from the same source. If all these canal intakes were located at the same point in a stream, the water apportionment to each would present fewer difficulties, but when the intakes are far apart and located in separate mountain valleys, it is very difficult to adjust the seepage and return waters from each system so as to reach an equitable division among all takers. These difficulties and complications give rise to controversies which too frequently lead to long-continued and costly litigation, the results of which are seldom satisfactory to any of the litigants. The need of water storage facilities is also a prime factor in most of the reconstruction problems. As a rule, the older irrigation systems depend for their supply on the summer flow of streams, the spring floods are uncontrolled and allowed in large part to flow past irrigable lands unutilized. Until these waste waters are retained behind secure dams, there can be no increase to speak of in the irrigated area. On the other hand, the best sites for reservoirs have already been put to use and few single irrigated enterprises are financially able to construct dams on those that remain. Thus further progress is impossible without more

water for irrigation and more water can only be had by the cooperation of the entire community. It is only by organizing rural communities in much the same way that cities are organized under a public corporation that the flow of western streams can be properly controlled and utilized. By uniting all the water users on a stream, controversies and litigation over water rights are prevented and ample security is afforded for the issuance of long term bonds for the construction of storage reservoirs and other works.

IRRIGATION CONDITIONS IN WEBER COUNTY

Irrigation conditions in Weber County are more or less typical of those prevailing in the older irrigated valleys of the West. As a result of a recent investigation, there would appear to be over 4,000 irrigated farms, 149 more or less independent ditches, and a partially irrigated area of from 35,000 to 50,000 acres, depending on the water supply in the creeks and rivers. There can be no question as to the intelligence and industry of the Weber County farmers and their families. If given a chance they can hold their own with any other rural community. Trained from infancy to regard cooperation as fundamental, the get-together spirit should not be wanting in any undertaking requiring the good will and support of all. Nor is irrigation a novel and untried method of farming. They have grown up with the practise and are familiar with the many details so necessary to bountiful harvests. All such men need is an opportunity to show what they can do, but this they have never had. Over forty years ago the late summer flow of Ogden and Weber Rivers had been over-appropriated, and since then little progress was possible. The making of new ditches to divert more water had to be done as a rule at the expense of prior right owners. It was a case of robbing Peter to enrich Paul. The need of more water after the spring floods had subsided was also rendered more acute by a change in the crops grown. In pioneer days grain was one of the staple crops and as cereals of all kinds mature early, the need for late water was not so keenly felt. In course of time, however, more alfalfa and still later more root crops and vegetables were grown, but the extent to which these more profitable crops could be produced has always been limited by the lack of water at a season of the year when such crops required the largest amount of moisture.

Furthermore, the shortage of water and the inability to grow the most profitable crops reacted unfavorably on the growers themselves. Realizing that further progress was not attainable under existing conditions, a tendency to stagnate was created. The structures of some of the irrigation systems were allowed to decay, ditches were neglected and little effort was made to economize the scanty flow or to deliver at stated intervals the amount of water which belong to each user. It was not feasible or even economical to prevent seepage losses in so many main and secondary channels by concrete lining, since the cost might have exceeded the value of the farms irrigated, so a large percentage of the valuable water diverted from the stram was wasted in transit and this waste water collected in all low-lying places and in time rendered valuable land only fit for pasture.

This, in short, is the condition of irrigation in Weber County today, and unless steps are taken to remedy the many defects, further progress is impossible. Retrogression is more likely to occur, brought about by the water-logging of the most fertile land by the accumulation of seepage water from the multiplicity of ditches in use.

What is the remedy? What plans can be formulated and what measures adopted that will give the farmers of Weber County the opportunity they have been longing for? The crying need is for more water for the irrigation of late crops and more water for the irrigation of thousands of acres of fertile raw land, for which there is at present no supply. Is there water to be had? Yes, an abundance if money is provided to secure it. The main issue is therefore to devise ways and means of raising money to build dams which will hold back the flood flow of the available rivers.

But stored water is not the only requirement. There must be a reconstruction and consolidation of existing ditch systems before stored water can be economically applied to the land. To store water at a high cost and turn it into 149 earthen ditches improperly located and poorly built might do more harm than good. Running water all summer long in so many leaky channels might waste so much water as to water-log most of the irrigable lands of the county. The wet lands would then require drainage and since individual farmers would be powerless to bring this about, communities would be compelled to organize in order to effect drainage. This, we think, would be putting the cart before the horse. It is proposed to organize for the purpose of securing more water and of putting the various canal systems in proper shape and to have this same organization handle at a later time the disposal of the waste water by means of proper drainage. In regard to the type of organization to be used to accomplish the objects sought, the landowners of this vicinity have little choice. The irrigation district act recently passed by the Utah Legislature seems to present the only means of uniting the owners of some 90,000 acres of irrigable lands. Thus far the Act has not been fully tested either in practice or in the courts, and it would be premature to criticise it. In the event that some of its provisions need to be modified to conform more nearly to such conditions as Weber County presents, the legislature at its next session a year hence may be depended upon to enact all needed amendments.

Briefly summarized, the Act is designed to unite the landowners of a community in such a way that each will contribute his proportionate share of the security given and the expenses incurred, have a voice in its management and an equitable share in its benefits.

OUTLINE OF PROPOSED DISTRICT

It might be well to consider briefly what is likely to be accomplished under such an organization and the first in importance would seem to be the water supply. Leaving out of consideration the small amount of moisture derived from summer rains, the water supply may be divided into two parts. One of these represents the amount of water at present available and the other the amount of additional water to be obtained to supplement partially irrigated lands and to furnish a full supply for non-irrigated lands. The available supply varies with the season and with the months of each season. It is accordingly advisable from an economic standpoint to vary the additional supply so as to avoid a shortage in dry years and a surplus in wet years.

A further consideration of the water supply has led us to divide the irrigation season into two parts; under the caption of early and late water. Early water, according to this division, would be the amount used from the beginning of the irrigation season until July first, and late water would be the amount used after this date. The rainfall of early spring and the large volumes available in most of the creeks and rivers

will furnish, it is believed, sufficient water for the lands now irrigated and for the raw lands to be irrigated, until the first of July of each year. In this belief we have excluded the early water supply from our computations and have dealt only with the existing and additional water supplies for the months of July, August and September. The estimate of the available flow in dry years from Ogden and Weber Rivers and all other sources of supply is in round numbers, in acre-feet, 14,000 for July, 12,000 for August, and 10,000 for September. These figures represent, it is thought, a fairly close average of what may be depended upon in several of the driest years which have occurred from 1889 to 1918 inclusive. In computing the normal flow for this same period, it is found to be about $2\frac{1}{2}$ times as much as it is in the driest years. Thus the amount available for July is estimated to be in acre-feet 35,000, for August 30,000, and for September 25,000. On the assumption that something like 90,000 acres will be included in the district, the total amount of water required after July 1 will be, according to our estimates, 166,000 acre-feet. This would call for an additional amount of water in dry years amounting to 130,000 acre-feet, whereas in normal years 76,000 acre-feet would be sufficient and in wet years still less would be required. Now, to save expense and at the same time stabilize the water supply, it is proposed to make all stored water delivered through gravity canals constant. To illustrate, if 40,000 acre-feet can be stored annually on the tributaries of Ogden River, this water would be used in wet as well as in dry years. On the other hand the amount of water which is stored in Marsh Lake Reservoir and raised by pumps to be delivered to canal systems will vary with the season. In years of scanty flow, the entire storage capacity of this reservoir may be utilized and it may even be partially refilled with water pumped from Bear River while in wet years the cost of pumping water can be greatly reduced because much less will be needed from this source.

WATER ALLOTMENT

In making the water allotment, careful consideration was given to all those factors which influence the use and duty of water. These included early and later water, the value of water, soils and subsoils, rainfall, crops, topography, size of the holding, water delivery, proper channels and structures, diversified farming, fertility of the soil and the like.

The amount of early and late water, as well as that which each type of soil should receive is shown in colors on the water allotment maps and the total seasonal allotment to each landowner has been tabulated. This tabulation gives the name of the landowner, the location of the land by section, township and range, the area of land owned by each individual within the district, the area of irrigable land, the water allotted in acre-feet per acre, and the total number of acre-feet allotted to each parcel of land, which represents the number of votes the owner shall have at any district election.

DEVELOPMENT OF ELECTRIC ENERGY

The elevation of the discharge pipe of the Magpie Reservoir site on the South Fork of Ogden River is 5235 feet above sea-level. That of the intake of the 6-foot pipe, the property of the Utah Power and Light Co. located near the junction of Wheeler Creek and Ogden River is 4818 ft., giving a total fall of 417 feet. The effective head of the Power Company's pipe line between the intake and the power plant is 425 feet. An

opportunity is thus afforded of developing electric energy by means of the water discharged from the Magpie Reservoir and intended for use on lands west of the mountains. The upper power site located between the reservoir and the upper end of Ogden Canyon, insuring a theoretical output of 6000 H.P. might well be held over for future use but the lower site can be utilized as soon as stored water is available, owing to the existence of the plant of the Power Co. The quantity of stored water from the Magpie reservoir which can be conveyed through the Power Co's pipe line during July, August and September of each year will depend upon the relative needs of the water users of Ogden Valley and those in the lower valley. In case it is feasible to store 35,000 acre-feet in this reservoir, it is reasonable to expect that 20,000 acre-feet of this total volume can be conveyed to the lower valley and while passing through the pipe line and the power plant, it would develop a theoretical energy equivalent to 8000 H.P. This amount of power, less the loss in generating and transmitting it, would be sufficient to meet all the demands of the district for power in all but the driest years.

In conducting that part of the water stored in Magpie Reservoir for use in Ogden Valley, a further opportunity is presented for developing power. The fall from the reservoir site to the intake of the Huntsville mountain canal, together with part of the reservoir head, is over 100 feet and the amount of water available would produce a theoretic energy of over 1000 H.P.

When the necessary surveys are completed, there may be found still another opportunity to develop power from the waters stored in Middle Fork Canyon, so that all things considered the chances would seem to be very favorable for the development of all the power needed and this in turn would insure very low rates for the electric energy required to operate pumping plants.

EXISTING WATER RIGHTS

During the period from 1893 to 1898 inclusive, the writer and his assistants representing the State and Federal Governments made a large number of measurements of Ogden and Weber Rivers and also of the ditches and canals diverting water therefrom in Weber County. The results of these measurements are for the most part still available and they shed considerable light on conditions pertaining to the water rights of this county as they existed a quarter of a century ago.

In 1903 and 1904, A. F. Doremus, then state engineer of Utah, and his deputies, made a hydrographic survey of the irrigated and irrigable portion of Weber County for the purpose of defining and adjudicating the water rights of Ogden and Weber Rivers. For reasons which need not be given here, the adjudications were never made but maps and summaries of the data collected are on file in the office of the state engineer. This work consisted in making a survey of all irrigated and irrigable lands, property boundaries, ditches and canals, creeks, rivers and other sources of water supply as well as the location and extent of the principal crops grown. Measurements were also made and continuous records kept of the flow of water in all irrigation channels during the irrigation season of 1904 and a partial record was obtained of such flow in 1903. Since 1904 was a year of average water supply, the results of measurements made by competent and disinterested parties on 149 ditches and canals located within the proposed district possess a high value. The area of land actually irrigated in that year by both early and late water was 38,068 acres and the amount of water applied to this area was

34,389 acre-feet in July, 30,099 acre-feet in August and 26,141 acre-feet in September, or 90,629 acre-feet for the three-month period beginning July 1.

In order to secure more recent information in regard to water rights and the use of water in Weber County, a questionnaire as given below was prepared and a copy mailed to each landowner. Through the assistance rendered by the Farm Bureau and the Extension Service of the Agricultural College of Utah, returns from a large percentage of the questionnaires issued have been received and the information contained therein tabulated for future use.

In reference to the quantities of water now available, the replies as given in the questionnaire show with very few exceptions a distressing shortage of water during the greater part of the crop-growing season. The spring rains combined with large volumes in the streams, provide, as a rule, for the months of May and June, but both rainfall and surface flow diminish rapidly during the first part of the summer season and little remain for the irrigation of the profitable crops that require a maximum amount of moisture in mid-summer. In consequence it is difficult to determine the actual extent of the irrigated lands in any one year or to draw a sharp line between the irrigated and non-irrigated areas. In years of scanty water supply the quantities available after the first of July would not serve more than about 20,000 acres, whereas attempts are made to irrigate partially a much larger area every year.

APPRAISAL OF EXISTING WATER RIGHTS

In the event of the organization of the district and the issuance of bonds, it may be necessary to appraise certain rights to the use of water within the district. Knowing that an appraisal of this kind might have to be made soon after the district is organized, an effort has been put forth to collect wherever and whenever possible, all information pertaining to this subject. This information will be made available to the board of directors upon request. Furthermore, if any assistance is desired by the Board from this Bureau, in making the appraisals, it is believed the necessary permission can be obtained.

The existing water rights within the proposed district may cover nearly 50,000 acres and include rights ranging from those of little value to superior rights of high value. The maximum value of a complete old right will be necessarily dependent upon the value of the new rights. To illustrate, if the par value of the new rights is placed at \$60 an acre, the best of the old rights could not well exceed this value without doing an injustice to the proprietors of non-irrigated but irrigable lands. One might go farther and state that no owner of an old right, however perfect, should be compensated for its full value since he is reasonable certain to be benefitted as a result of the organization of a district. He may own dry land that he desires to reclaim, the water service under the new system is likely to be much better than under the old, and he is certain to share in the general prosperity of the county arising from a doubling of its irrigated area and a corresponding increase in the value of soil products raised. Besides there may be a legal phase of the question which should not be overlooked. If a full right is allowed to any tract of land, a question might arise as to the extent of the benefits conferred on such tract and whether it would be subject to its share of assessments and the payment of the interest and principal of the bonds. For these reasons it would seem advisable to limit the appraisals of the most complete rights to 95 per cent of the value of a full right. On the

other hand, some inferior rights might not exceed 10 per cent of a full right. This wide range of values calls attention to the necessity, as has been stated, of listing, classifying and appraising all existing water rights.

COST OF WATER UNDER THE PROPOSED DISTRICT

So great at times has been the shortage of water and so heavy the losses incurred in not having an adequate supply, that the farmers of Weber County are not disposed to quibble over costs. They want more water for late irrigation and are willing to pay any reasonable amount in order to secure it. On the other hand they are conservative and wish to know in advance whether the benefits to be conferred will justify the expense. They hesitate to incur financial obligations before having a fairly definite idea of what the extent of the obligation will be.

In the absence of surveys and the usual estimates of cost of structures, it is not possible to give at this writing a wholly reliable figure as to the cost per acre for a full water right. It is believed possible, however, to make a fairly close estimate and such an estimate at the present stage of proceedings is likely to prove advantageous in aiding the land owners of the county to reach the right conclusions as to their proper course of action in respect to the proposed district organization.

In the new works to be built, the largest single item of expense will be for the storage of water at the several sites. The cost of storage per acre foot will vary with the site. In the case of the Lost Creek reservoir in Morgan County, the cost may reach \$55.00 per acre-foot, those of Magpie and Middle Fork may exceed \$30.00, while the Marsh Lake reservoir is reasonably certain to be under \$20.00 per acre foot. Assuming these unit costs to be approximately correct, and multiplying the cost per acre-foot with the number of acre-feet stored in each case, the total aggregate for storage in round numbers amounts to over \$2,500,000.

The next largest item of expense as regards the district will be the exchange of district bonds for existing water rights. In transactions of this kind, the bonds or their equivalent in money will be retained by the people of the district and will reduce to the extent of their appraised valuation the amount to be paid for a new right. If, as has been estimated, there are now partial and full rights to something like 50,000 acres, and that the evaluation of these rights is likely to vary all the way from \$10 to \$65 an acre and average about \$40 an acre, bonds to the value of \$2,000,000 would have to be voted by the district in order to compensate owners for rights now held.

In addition to these two large items, smaller sums of money will have to be expended for the installation of power plants and steel discharge pipes, for intake and diversion canals, for the enlargement and reconstruction of existing canals, for the interest on the bonds during the construction period, and for other requirements of the district.

A rough estimate of the cost of all these would seem to indicate that the cost of a new water right for land not now irrigated would be nearly \$70 an acre and that the cost of such a right for land partially irrigated would vary from \$5.00 to \$60.00 an acre depending upon the value of the old right.

In regard to the manner of paying for water rights under the district form of organization, the following course is recommended.

1. That no part of the interest or construction charges be called for during the construction period which is estimated to extend over a period of two years or to the beginning of the irrigation season of 1922, the only

charge during this period being for the operation of existing systems and for the operation of any additional water that may be furnished.

2. That for a period of nearly five years after the necessary works have been completed, or from January first 1922 to December 31, 1926, only interest and operating charges be required, and

3. That beginning with January 1, 1927, annual levies be made for the payment of maintenance and operation expenses, interest on the bonds and the one-twentieth part of the principal on the bonds. The course herein outlined is further exemplified under the next heading.

PROCEDURE RECOMMENDED

Under the District Act, the sequence of events and the proper procedure to follow is in the main set forth, but a brief review of the more essential features to be handled may tend to expedite matters, prevent mistakes and insure a larger measure of success in the end. The first steps in the organization of the proposed Weber County irrigation District have already been taken. A petition signed by the governor has been filed with the Board of County Commissioners and this Board in turn has requested the state engineer to make a water survey and allot the amounts of water which can be beneficially and economically used on the lands included within the territorial limits of the proposed district. This is as far as proceedings have gone at this writing (Jan. 9, 1920). It will now devolve on the state engineer to file with the Board of County Commissioners his return of survey and report of allotment and thereafter for the Board to make public notice of this fact and to set a date for the hearing of applications for exclusion and inclusion of lands and revision of allotments. The time required to give legal notice of this hearing will occupy about 30 days but it is believed the time required for the hearing will be short owing to the fact that the opinions of the landowners interested are for the most part fixed or at least will be by the time the hearing is held. At the close of this hearing the Board shall fix the boundaries of the district and plat and list the lands included with the corresponding water allotments. This being done, the Board will then call an election for the formation of a district and the election of officers at the same time submitting the names of landowners to be voted for as members of the board of directors. A further delay of about 30 days will then be necessary in order to comply with the law in the giving of public notices of the pending election.

In the event that the district is organized and a board of directors elected, it will require some time for the members of the board when organized, to attend to the more urgent duties of their office. With these duties accomplished, the next important step should be the calling of another election for the purpose of voting bonds. The public notices to be given prior to the holding of the bond election will require the same time as for an election to organize, viz. a minimum of four weeks. It will thus be seen that under the most favorable conditions the hearing cannot be completed before March or the election held until some time in April and the result of the election for the sale of the bonds before the first of June.

The popularity of the movement to create a district will not be fully known until after the bond election, since this will form the best test of the wishes of the rural communities within and adjacent to Weber County. It will be recalled that a bare majority can organize a district but that it requires a two-thirds majority to vote bonds. It would there-

fore seem best to expedite proceedings as much as possible until this final test is applied.

In conformity to this view only such affairs should be handled as the law requires, and as little expenses incurred as possible between the date of organization and the time when the results of the bond election becomes known. There is always the possibility to consider of a district being organized, followed by the failure to secure a two-thirds majority for the sale of bonds.

In reference to the extent of the bond issue, it would seem wise to have the electors vote on the full amount required for all needed construction and for any water rights that might be transferred. The bonds need not be sold until money was needed, and although a large bond sale was authorized by the electorate of the district, there would be no charges incurred in the form of interest until they were disposed of to pay contractors for work performed, materials furnished or for other expenses.

With the question of bonds out of the way, the officers of the district would be free to plan the entire construction program and to carry out such parts as would bring relief in the shortest possible time to those needing water.

PRESIDENT WIDTSOE: Our next speaker is a man who is pretty well known as an irrigation worker in the State of Utah; he is the kind of man who dreams practical dreams, if you know what that means; he is also a good fellow chiefly because he was my student at one time when he was a little fellow. I take pleasure in calling upon Mr. L. M. Winsor who will address us upon the subject of "Summary of the Present Status of Centralization in the Management of Utah Irrigation Systems." Mr. Winsor.

MR. WINSOR: Mr. Chairman and Gentlemen: If I am a dreamer of dreams it is because of the influence on my life of such men as Dr. J. A. Widtsøe, Dr. Samuel Fortier, and my esteemed friend the late Lewis A. Merrill, all of whom have had a great deal to do with shaping the course of my career and in causing me to leave the field of civil engineering as applied to railroad location, construction, and maintenance, and take up my life's work of irrigation engineering in its relation to applied agriculture.

The history of irrigation development in Utah has been extremely interesting. In the year 1847, on July 24th, a small body of Mormon pioneers entered Salt Lake Valley. They brought with them a collection of seeds of various sorts, and though it was late in the summer at the time they entered the valley, they realized the necessity of planting crops in order that seed might be produced for planting the following year. So they attempted to break ground near the present site of Kieth-O'Brien's store in Salt Lake City. The ground was so dry that it was necessary to moisten it before they could plow. So Wilford Woodruff and some of his associates dug a ditch from City Creek, moistened the ground, and the next day planted some potatoes and other crops. Thus modern irrigation had its birth, as has been referred to by Dr. Fortier and also as indicated

in President Widtsoe's discussion of irrigation throughout the State. From that beginning has been developed our irrigation practice as we have it today. The growth was very rapid for a short time. Under the able leadership of Brigham Young settlements sprang up on practically every stream throughout the State and in many of the adjacent sections in other states wherever water was available for irrigation, until the primary waters of the streams were utilized. Then development by irrigation apparently stopped,—as a matter of fact, for about 40 years we stood practically still. In some of our communities until about seven or eight years ago there was less land under irrigation than had been handed down by the early pioneers to their sons and daughters, which shows an actual retrogression in irrigation development. But with the new awakening along with the development of reservoirs for storing the flood waters which were wasted annually, there came a more economic development in the use of our irrigation systems. And so we have given some attention to that question, but as was indicated so well by Dr. Fortier, we have not made the progress in this State that has been made in the other states in the West and we find ourselves far behind some of our sister states in the matter of development. We are not behind all the states, I am glad to say, but unless we sense the responsibility that rests upon us we will drop into the background with such states as Montana, whose irrigation laws are antiquated and sorely in need of revision. Montana, however, has awakened to the fact that something must be done, and you can look for rapid development in the next few years in that state,—but here at home it depends on us as to what we are going to accomplish in the way of improving our conditions.

Now about the year 1911 we began our propaganda throughout the State for the purpose of revising, re-organizing and consolidating some of our irrigation enterprises. As you will agree our irrigation systems are made up of numerous small systems which have been developed one at a time—the easiest of construction being built first and the more difficult later on, with the result that our primary water rights are held in the main on the low lands,—the lands lying on the bottoms of the valleys. The upper sections of the valleys have been irrigated later on by flood water rights, with the result that we are just upside down in the economy of our use of the streams—in the main. In other words we apply the primary water rights to the lands that need water the least. Those lands have become more or less water-logged as the water has been applied to the bench lands, and the nature of the valleys is such that the upper country does not water-log very much, with the result that large quantities of water are used there wastefully and the excess finds its way down to the low lands, which makes it necessary to drain rather than receive an additional supply. However, the condition of our water laws is such that the primary rights are held on those low lands and the upper country must suffer. So there is no co-ordination in the distribution of the waters of the State.

In an endeavor to bring about a better distribution of the water we attempted several years ago to effect a combination of several irrigation systems so that the best results might be obtained. The Ashley Valley is an example of one condition that needs adjustment and needs it badly. It was suggested to those people in 1911 that they revise their existing water systems and combine into one company for the better distribution of the waters. They have numerous canals serving some 30,000 acres, but from the amount of water carried by these canals at low water time very little good is realized. They have a system out there of continuous flow distribution. Each farmer is entitled to a continuous

stream and you can readily realize that in the summer time when the water is low those streams are very small, so that when it reaches a farm, unless the users themselves combine their streams, there is little more than enough to irrigate a garden space. There is a tremendous loss in the canals and in the laterals—a tremendous amount of evaporation, as well as seepage loss, so that a very little actual good is accomplished during the irrigation season. And during the time that there was very little market for their crops they had little incentive to discontinue the bad practice of letting water go to waste. I have known of farmers turning water on a strip of alfalfa and going off to Price for a load of freight, leaving the water running in one place until his return eight or ten days later. Thus wasteful practices developed which not only failed to irrigate the land needing water but also has resulted in water-logging a large body of valuable land. That is one example of waste and of the necessity of finding some means of remedying such conditions. Before leaving that section, I will say that the work has been continued out there and they have finally become interested in the matter and are planning to do something to correct their condition. I just received yesterday a clipping from their paper discussing the question and in one paragraph it says: "Ashley Creek was flowing at low point 55 second feet of which amount there was a loss in distribution of 41 second feet with the result that only 14 second feet reached the land." I don't think those figures are correct,—he may have stretched it a little, but it is some indication of what is being done out there and there is some hope that eventually the companies may be brought to gether and organized in a single operating company. It remains for some corporation to study the situation and recommend a course of procedure.

One of the first attempts at organizing a community in the consolidated form of operating company was made at Beaver. There we have a typical example of the loss that is sustained through an inadequate method of handling the water supply. We have a valley that is almost circular in form with the margin being made up of more or less porous soil and the bottom lands of heavy soil. There were ten companies operating in that small valley covering an area of less than 10,000 acres, and the oldest company has, of course, the best water rights. The oldest rights are down on the low lands where the ground is so wet that a cow can hardly walk across it,—she has to walk thru it. On the upper ground they have only a flood water right. In 1914 a series of meetings was held with those people and they were brought together and interested in the matter of consolidation. Of course, many of the people are interested in more than one of these ten canals,—one man may have an interest in several of them, paying taxes for the upkeep of the different systems and be perhaps, a company officer in the different systems. The matter was called to their attention of the loss in that method of operation. They decided the best thing to do was to follow our suggestions and unite their interests, so a committee was formed to find out how many of those people could be brought in. About that time some ill-advised attorneys got to work and found out they might be turned out of a job if these people organized that way so they threw several of these companies into litigation and they have been in that condition ever since. We concluded it was inadvisable to continue our work until they were out of court. You can see how much lost motion there is; how much lost efficiency and where they are going to come out in the end. They must, before they can settle their questions, take them out of court and arbitrate the situation anyhow. They will have all the expense they have had for their pains of throwing the matter into court and they will not be any further

ahead in the end. That is where this particular matter stands today. When the importance of this work was realized another district on Indian Creek, a little district known as Manderfield, where we were able through the assistance of the County Agent to organize the Manderfield Irrigation Company for the distribution of the waters of Indian Creek. We effected a corporation, dissolved the original companies and brought them under one head so that they are now operating as a single unit. In the process of re-organization they built a new branch of their main canal and a new intake and diverted the waters of Indian Creek some five miles above where they were originally diverted, thus avoiding a long run thru a dry sand wash, saving a good deal of water in transit. A better distribution of the water was effected through putting in of measuring devices. In short they rebuilt the entire system and this at a very low cost to them.

While there have been some disappointments to us in not carrying out a complete outline or program given them, yet in the main the work has been satisfactory and they are reaping the benefits in the increased amount of land the system is able to serve. Another section that has realized some benefits through organization is the South Ditch Company near Sandy, which was brought together some two years ago. After the consolidation of interests, I drew up articles of incorporation which I have here and brought their scattered interests together and they are now operating as a single unit, which formerly was a division of interests. They have appropriated part of the waters of Utah Lake which covers that portion of Sandy and have united them with their own stream, so that they are now reaping the benefits of a combination which gives them a full stream all summer.

Those two examples are the sum total of the accomplishments which have been attained in this state during the time we have been endeavoring to bring these people together. There are a number of systems under consideration; they are operating with the end in view of bringing their interests together, but up to the present time this end has not been accomplished. One of the striking examples of this class is that of Coal Creek near Cedar City, where we have a fairly large system compared with other systems of the State; not large compared with California systems which Professor Adams will discuss, but large compared with some of the ditches in our small communities. We have in the decree that was issued in 1901 by Judge Greenwood a classification of seven classes of water rights from Coal Creek. Some of these systems parallel each other for a distance of five miles and at low water time last year two of the branches that I have in mind that run five miles parallel carried less than two second feet in total. Right here let me say that this is one of the greatest wastes,—the practice of using a small stream in attempting to irrigate. It is much more desirable and much better practice to combine several of those smaller streams and have all that a man can handle on his farm while he is at it so that he can get over the ground and give the stream every moment's attention while it is running. Under the Coal Creek we have been studying the problem for three years. Mr. Fife who is here today has been down there conducting a series of experiments in determining the amount of water which it is necessary to use on those lands. Another engineer, Mr. Gardner has been measuring the waters distributed to those canals and last year acted under the State Engineer in distributing the water from Coal Creek. Last summer they drew up articles of incorporation which were proposed to unite or consolidate the various canals and interests. They proposed under these articles of incorporation to classify the water into two classes, instead of seven, allowing those rights which were patented prior to the

year 1903 to stand as Class A and all subsequent rights to stand as Class B and operate the entire system by that method of distribution. We have tried to keep this Coal Creek system out of court and thus far we have been successful. There has been no effort on the part of the users to throw the question into court for settlement, and it is believed under the direction of the State Engineer an amicable settlement can be obtained on that steam, and we hope that the next season will accomplish that end so that ultimately they will be able to make a most satisfactory distribution of the waters of the system and to obtain the best results possible. There is also a difficulty in bringing this about because there are some users who will hang back for fear some one other than themselves may benefit by such action. It is a difficult question to handle. It takes years to accomplish what should be accomplished in months, but the people are gradually coming around to the way of thinking that we have indicated,—that they must consolidate their interests to get the best results. Now I don't want to hold you longer in a discussion of this problem, but I say to you that the engineers and water users who are assembled here can be of much assistance in bringing about the end which it is desired to accomplish—in consolidating our interests to the point where we can attain the greatest efficiency in the development of irrigation in Utah, and I hope we can work together to that end.

IRRIGATION DISTRICTS AS A FACTOR IN CALIFORNIA AGRICULTURE; THEIR USE AS AN AGENCY IN IRRIGATION REORGANIZATION

By FRANK ADAMS

Irrigation Investigations, University of California
and U. S. Department of Agriculture

In the field of irrigation organization, the development and establishment of the irrigation district idea have been the most important steps in the history of California irrigation.

Under no other form of organization has so much been accomplished in the ownership and management of irrigation works; the irrigation district offers practically the only means of financing large irrigation undertakings; it has been almost the only agency that has been found adapted to the taking over, reorganization, and enlargement of irrigation enterprises started by private capital that have ceased to be satisfactory, and in somewhat modified and extended form, and possibly with more or less financial and supervisory participation by the State or Federal government, or both, it offers the only promising plan that has been suggested for the next step in California irrigation development,—the consolidation of irrigation enterprises for the storage and distribution of flood waters on large stream systems, such as the Sacramento, the San Joaquin, the King's, and the Kern.

ACCOMPLISHMENTS OUTSIDE OF IRRIGATION DISTRICTS

It is true that California has done much in irrigation outside of its irrigation district activities. Several hundred mutual water companies

have brought about the irrigation and made possible the settlement and development of the attractive communities that surround and support Los Angeles, Pomona, Redlands, Riverside, Santa Ana, Santa Barbara, Ventura, San Diego and the other rich centers south of Tehacapi; private capital, largely associated with stock raising, has accomplished the irrigation of extensive areas in Kern County and in San Joaquin Valley north of Fresno; scores of simple farmers' cooperative associations, later in part followed by large commercial enterprises, have brought water to nearly a million acres in Fresno, Kings, and Tulare counties; private capital has thus far led in the irrigation of Sacramento Valley; and individual and partnership enterprises have brought under irrigation farming a larger acreage than any one of the other types. Yet from Imperial and San Diego on the south to Trinity, Siskiyou, and Modoc counties on the north, the one idea underlying practically all new community irrigation planning and reorganization, or that has been the motif of the more important planning and reorganization for at least five years back, is the idea of community ownership through the district plan of organization.

What has just been said is easily proven from the figures at hand.

In 1909 when the twelfth irrigation census was taken only 6.5 per cent of the land irrigated in California and only 11 per cent of the land covered by irrigation systems was in irrigation districts. This, however, was at the close of about a 15-year period during which the ill-repute of the pioneer irrigation district activity of the late 80's and early 90's had turned thought entirely away from this type of organization. But since that time the popularity of irrigation districts has been so great that their number has increased from 6 or 7 to over 50, the area irrigated in irrigation districts from about 150,000 to about 750,000 acres, and the area embraced in irrigation districts from less than 500,000 to more than 2 million acres. To be sure a number of these new districts will not progress much beyond the state of organization because of having been ill-advised from the start; yet of the number now organized at least 25, embracing over 1,300,000 acres, are well established and undergoing successful development and settlement; at least 11 others that have been recently organized embracing over 600,000 acres, have in them the elements of success; and approximately 1,000,000 acres additional are included in seemingly sound irrigation district enterprises now undergoing either active promotion or organization. Thus these already or prospectively successful districts embrace an aggregate area in excess of 1,900,000 acres, which certainly is not less than one-third of the total area under all California irrigation enterprises at this time.

NEW IRRIGATION DISTRICT LEGISLATION

The progress of irrigation in California under the irrigation district act, as outlined above, is not, however, all that the irrigation district idea has meant or is now meaning to California agriculture. From 1915 to 1919, two other important irrigation district acts have been passed and put into use in California,—the "Water Works District" act under which the San Fernando Valley areas that receive Los Angeles city aqueduct water, embracing 87,000 acres, have been organized; and the "water conservation" or "California Irrigation Act" which has been framed to make possible the reorganization, where desirable, of existing systems and the formation of new systems dependent on the same water source, neither of which is possible except through the storage of flood waters.

Drafted to meet the needs of Los Angeles in the utilization of its

acqueduct water, the "water works" district law does not seem likely to be used very widely, if at all, outside the immediate vicinity of Los Angeles. The California Irrigation Act, on the other hand, is already beginning to exert a very vital influence on irrigation district activity and deserves a careful understanding of its principal features. But before going further into this law it is desired to recount and explain in some particular the improvement and strengthening of the original California irrigation district act, popularly known as the "Wright Act," which have resulted in its present extended use.

IMPROVEMENT OF THE CALIFORNIA IRRIGATION DISTRICT ACT, 1909-1919

The passage of the Wright Act in 1887 was largely in the nature of a revolt against the larger land owners and riparian proprietors, and the formation of irrigation districts under it was sought to be made easy. In this respect, however, the law somewhat overreached itself, and at least a decade was required to bring about a realization that a majority of the substantial interests affected, whether of people or of land, in the case of very large districts, at least a very considerable proportion of such substantial interests, must be soldily behind any successful irrigation district movement.

In 1897, when the Wright law was revised and re-inacted, apparently with the idea of ending for some time at least, further irrigation district movements, the power of a few people,—“50 or a majority”—regardless of percentage of property owned, to propose the organization of a district was taken away. In place of this the revised law required the signatures of a majority of the land owners representing a majority in value of the lands, before a petition for the organization of an irrigation district could be brought before the appropriate board of supervisors.

Next, the law took away from the boards of directors of districts the almost unrestricted power they had previously possessed to call bond elections and to acquire water rights, works, and other necessary property, substituting for this a requirement that the calling of any bond election and the purchase of any property or works of a value exceeding \$10,000, should be preceded by a petition carrying the signatures of the same proportion of the land owners representing the same proportion of the value of the lands as required to propose a district organization.

These two radical changes of the Wright Act, which have been somewhat tempered by recent legislation, were notice that further irrigation district movements in California must be substantial, although the law still sought to withhold from the minority the power to block irrigation development indefinitely—especially the minority represented by the owners of large holdings and of great estates.

These reforms, aimed at greater safety, have been invaluable in restraining unwise ventures, but they did not touch the root of the early evil in the law; namely, a lack of workable bonding provisions and of public supervision of organization and financing. Strengthening the law in these features constituted the next forward step.

IMPROVEMENT OF BONDING FEATURES AND STATE SUPERVISION OF IRRIGATION DISTRICTS

The present popularity of the irrigation district in California really had its beginning in the successful outcome of Modesto and Turlock irrigation districts. These two districts, the first to be organized under the

original Wright Act of 1887, after years of controversy and litigation, finally reached the point of operating in 1903 and 1904, having funded their original bond issues with but relatively small loss to the original bond holders. It was several years before the success of these two districts was so fully assured as to lend encouragement for other communities to organize. By 1909, however, their success was unquestioned, and stimulated by their example, the communities directly to the north in 1909 organized Oakdale and South San Joaquin districts. But as soon as these two new enterprises were ready to proceed with their construction they found that their bonds were only salable at a large discount and then only through a collusion between construction contractors and bond buyers not sanctioned by the district law.

At first the promoters of these districts were inclined to blame investors, but this feeling soon gave way to an aggressive and concerted movement, on the one hand to remove defects in the bonding provisions of the law, and on the other hand to provide a measure of State supervision of irrigation district financing.

The first important changes in the bonding provision of the district law removed the previous restrictions on the sale of irrigation district bonds below their par value and specified that, instead of bearing only 5 per cent interest, which was less than the market interest rate for such securities, the interest rate should not exceed 6 per cent, which was above that rate.

These two changes in the law alone were a distinct step forward and permitted the new districts to save substantial margins in the awarding of construction contracts, for it was no longer necessary to evade the law by disposing of bonds through construction contractors.

Realizing that more than these changes in the bonding provisions of the law was necessary to regain the confidence of investors, the districts in 1911 had secured the passage of a law providing that after favorable report by the State Engineer, the Attorney-General, and the State Superintendent of Banks, the bonds of irrigation districts might become legal investments for banks, trust companies, insurance companies and State school funds, and become available as security for public funds. This law, however, had not given the State any supervisory authority over the expenditure of the proceeds of the bonds after they had once been certified by the three state officials named. Since 1913, however, the functions of the State with reference to irrigation districts have been gradually strengthened and enlarged; first by constitutional amendment making valid a revised draft of the act of 1911 above referred to; second, by referring the feasibility of irrigation districts to the State Engineer for report prior to organization; third, by charging the irrigation district bond commission, composed of these three State officials, with investigation and report on proposed expenditures by districts both prior to voting of bonds for that purpose and prior to their validation as legal investments for banks, etc., and as legal security for public funds; and finally, when bonds of an irrigation district have been certified by the bond commission, by requiring the consent of such commission to any expenditure from the construction fund of the district,—a provision, however, so drastic as to be if anything super-cautious.

IMPROVEMENT OF IRRIGATION DISTRICTS UNDER THE REVISED DISTRICT LAWS

Under the stimulus of these material changes in the California irrigation district law the affairs of irrigation districts in California have been

placed in much better shape than at any time in the history of the movement. No entirely unwise districts have been permitted to issue any bonds, for without assurance of receiving the approval of the Irrigation Bond Commission the voting of bonds would be useless, because they could not be marketed without such approval.

Whereas ten years ago the best of our 5 per cent irrigation district bonds only brought 85 or 90—bonds as secure from hazard as almost any bond that might be mentioned—they are now listed daily in the principal California papers practically at par; and 6 per cent-bonds of these same districts bring in excess of par. In fact the daily listing of California irrigation district bonds includes the bonds of nearly every established district in the State organized under the California Irrigation District Act, with prices ranging generally from 90 to 99 per cents and from par to 110 for 6's. While one or two of the districts approved by the Irrigation Bond Commission have not fully borne out the expectations of the commission at the time their bond issues were authorized, there has been no default by any of them, nor does any seem likely; and although some unwise districts have succeeded in organizing against the judgment of the State Engineer since the changes in the law above referred to—the State has not yet full veto power in the matter of organization—, the State has succeeded in preventing the voting of bonds, by such districts.

HELP TO IRRIGATION DISTRICTS FROM PUBLIC AGENCIES

Influential as these new features of the California law have been in inspiring confidence in California irrigation districts—practically no district that has obtained approval of its bonds by the Bond Commission has been unable to dispose of them at a fairly satisfactory figure—much strength to the irrigation district movement in the State has come from the active interest various State agencies, as well as the Federal Department of Agriculture, have been taken in their welfare.

The law makes it the duty of the State Department of Engineering to assist those contemplating the formation of irrigation districts, and although no State appropriation has been directly made available for that purpose, the Department of Engineering has been able to use State funds to a considerable extent in this work, more particularly where a portion of the cost of investigations is borne by the communities interested.

The same interest is now being shown irrigation districts by the State Water Commission—the State agency in California which has administrative charge of the appropriation of water—and for some years the College of Agriculture of the University of California and the Irrigation Investigations of the U. S. Department of Agriculture have devoted much time to aiding in the organization of worthy district projects and in their later development.

In other words, public agencies in California look upon proper irrigation organization under some district plan, where the owners of land control and where they possess the sovereign power of taxation for financing the construction, maintenance, and operation of necessary irrigation works, as essential to the proper development and prosperity of the State, and therefore worthy of their support. True the State has not yet all the authority it needs to keep unwise districts from being organized, nor all of the funds needed for proper investigation and for supervision of expenditures, yet these deficiencies are gradually being removed in response to, or at least with the concurrence of, public sentiment.

IRRIGATION DISTRICT MANAGEMENT BECOMING SATISFACTORY

One of the features of irrigation districts that in the past has had much to do with the unmarketability of their bonds has been their rather lax internal management. Fortunately there has been a gratifying improvement in this regard, and some of the California irrigation districts can be said to be models of good irrigation management. While in some of the newer district enterprises there is still much to be desired in the way of better business and engineering methods, there are already enough well-managed irrigation districts in the State to demonstrate that irrigators are themselves fully capable of handling very large and very important irrigation systems.

There are in California 6 successfully operating districts with areas exceeding 70,000 acres each, of which 3 exceed 125,000 acres, 2 exceed 175,000 acres, and one contains over 500,000 acres, with 400,000 acres already irrigated.

Under competent legal and engineering advice, and with varying degrees of State supervision, these California irrigation districts are now dealing in millions with more satisfaction to themselves and to those who finance them than ever has been attained under commercial irrigation enterprises in California in which the irrigators have had no voice.

THE REORGANIZATION AND CONSOLIDATION OF IRRIGATION ENTERPRISES UNDER THE DISTRICT PLAN

While some of the best possibilities of the irrigation district law have been realized in California with entirely new enterprises, still the law has been made use of in an important way in the re-organization of enterprises originally promoted and organized as what we ordinarily speak of as water corporations; that is, commercial irrigation enterprises.

At least 15 of the irrigation district enterprises in the State have had this history. In fact there have been practically no commercial irrigation enterprises that have been successfully re-organized except by the district plan, and of the important enterprises now in the process of working over, the formation of irrigation districts is the purpose in view.

Reference has already been made to the California Irrigation Act, framed in the interest of consolidation of irrigation enterprises for storage purpose, as exerting a vital influence on California irrigation districts and California agriculture.

This law was first passed in 1915 with a view to giving some State agency very broad powers in the matter of water conservation and distribution in the northern portion of Sacramento Valley. The storage and diversion of flood waters and the irrigation of land were held by the act to be matters in which the State has a paramount interest, and the powers conferred on the Irrigation Board established by the act were declared to be "police and regulatory powers" necessary to the accomplishment of a purpose that is indispensable to public interests.

In addition to being given power on petition of one-half of the land owners to form a somewhat simpler type of irrigation district than the "Wright" district, and patterned largely after California districts organized to reclaim swamp and overflow lands,—this is the feature of the act that is just now giving most concern—the Irrigation Board is empowered on petition of their governing boards to consolidate into single conservation districts irrigation, reclamation, and drainage districts, and on payment of their due share of the cost of storage or other reclamation works, to extend the benefits to be derived from conservation districts to

any private or mutual irrigation company. And for the purpose of carrying out the intent of the act, the Irrigation Board is authorized to levy assessments against the land within the conservation districts in accordance with the benefits to be derived, whether these benefits accrue from irrigation drainage, flood control, or reclamation of swamp and overflowed lands.

Furthermore, without any statutory instructions or limitation as to the basis on which it is to be done, the Irrigation Board is given power to apportion to the constituent units of the conservation district, and to the private and mutual companies admitted to its benefits, the water to be made available and the cost thereof,—powers probably broader than given to the boards of directors of irrigation districts in any of the states.

It is too early yet to forecast the results that can be attained under the very broad authority of the California Irrigation Act. The validity of the act is now before the state supreme court for decision. In the meanwhile, plans are well along for the formation of the first conservation district covering 3 or 4 out of what ultimately will include at least a dozen or more independent units taking or desiring to take water from Kings River about Fresno. These units will include at least 2 types of irrigation districts—districts organized under both the California Irrigation District Act and under the California Irrigation Act, and probably there will be at least one private irrigation company for the present not a part of the conservation district that will participate in the benefits.

The retention of these independent units is considered desirable in the case of this proposed conservation district about Fresno because of the large area involved, the present area irrigated approximately 500,000 acres, and the ultimate planned irrigated area being from 800,000 to 900,000 acres. Storage by this conservation district is projected at the Pine Flat storage site on Kings River to the extent, probably, of 600,000 acre-feet, and at a cost estimated at pre-war prices approximately ten million dollars.

OBSTRUCTION UNDER THE CALIFORNIA IRRIGATION ACT

While the intention of the California Irrigation Act is generally as outlined above, use has recently been made of it to obstruct organization under the Irrigation District or Wright Act,—or at least to keep certain large areas from being included in Wright Act districts.

As already stated, the powers granted to the Irrigation Board by the California Irrigation Act include the power on petition of one-half of the land-owners affected to create a new and somewhat simpler type of irrigation district.

During the past six months certain large landowners in San Joaquin Valley have filed petitions with the Irrigation Board for the formation of such districts within proposed Wright Act districts in process of formation, and it has not yet been clearly shown that the Irrigation Board has power under the act to refuse the petitions. In other words, a law framed to bring about consolidation and progress is being used in a way that holds back forward irrigation movements that in at least one case can hardly succeed in the face of this interference. However, this is only of passing interest at this time, and is referred to only to illustrate some of the difficulties that must be expected when the larger problems of water storage are undertaken.

THE OPPORTUNITY OF THE FUTURE

With the very material strengthening of the California Irrigation District act through introducing a larger and larger measure of State supervision during the period of financing and construction, and with a plan developed and (unless the law is held unconstitutional) soon to be tried for the consolidation of existing and new enterprises on a large scale to bring about water storage and elimination of wastes incident to an entirely independent and frequently antagonistic operation of irrigation system—the extent to which the individual units will retain their identity being likely to depend very largely on their size and the size of the whole project—California seems to be entering the most promising period in her irrigation history.

Large-scale water storage for irrigation purposes it just beginning to be seriously undertaken, yet enough water economically susceptible to storage runs annually to waste in California at least sufficient to double the present irrigated area.

In the coming decade 10 to 20 millions of dollars will not be unusual figures in the cost of California irrigation district projects, and there are some who believe that the proper financing of these large projects requires and warrants the use of State or Federal credit or both, with of course a due degree of State or Federal control during construction and while the projects are being established.

Some feel that the State itself should lead in the financing and construction of this large-scale storage both on the principle that this is properly a State function, and also because that State is likely to be most successful in obtaining Federal assistance that is itself most ready to lend its own help.

The chief money value of the use of public credit, properly advised and conservatively guarded, for water conservation is mainly the saving in interest rates between the 6 or more per cent the newer irrigation districts are paying on the basis of their own credit and the 4½ or 5 per cent that would be paid on State or Federal bonds backed by State or Federal credit. The Commonwealth Club of California, the largest civic organization in the State, with over 2500 members, is already interesting itself through its irrigation committee in this matter, and a bill calling for a beginning of State reservoir construction framed by this committee was carried through the last legislature, but, probably through misunderstanding, failed of executive approval.

At any rate, with the increasing cost of irrigation construction, especially where very large storage projects are involved, the absolute urgency of effecting every possible saving in bond interest seems rapidly to be bringing the matter of using State credit in irrigation construction to the point of making it a definite issue of State governmental policy.

ADDRESS

By **CALEB TANNER,**

Formerly State Engineer of Utah

Mr. President and Gentlemen of the Convention:—I am a baptized member.

PRESIDENT WIDTSOE: Of the Shakespeare Club? (Laughter).

MR. TANNER: I was born and raised in this community and I have not quite recovered from the conservatism that I got with my inheritances. (Laughter and applause).

The situation in Utah is peculiar because we are a peculiar people. We have been blessed and set apart by ourselves to fulfill a definite purpose in the world, and we are mighty chary of receiving direction from any one else. (Applause). We broke the way as far as the white man's efforts were concerned in the beginnings of irrigation, and we have been wearing the decorations therefor ever since. I believe a great Admiral of the American Navy said before a Senate Investigating Committee, that if he were to wear all the decorations that foreign nations had conferred upon him he would be a little lop-sided; and I think we are about the same, with the multitude of decorations we have been wearing by reason of our being the pioneers.

We have done some things wisely, for which we should receive due merit and consideration; and we have done some things unwisely, for which we suffer the penalty, even to the third and fourth generation. We have gone through experiences—not ourselves particularly, but our ancestors—because we have been here a long time. I am past the meridian of life, and Provo was a city of the first class when I was born! (Laughter).

Now, every beginning has to have all the disadvantages of any genesis. No one who has studied the institutions of irrigation in the State of Utah, from those earlier sages who have gone to the glories beyond—like Mr. Powell—down to the time of Mr. Mead, and even to Mr. Adams, has ever said that we did not begin well. We had the right idea and we carried it out for a long while, and then turned apostate. And you know what it is to be an apostate to an idea or an ideal in our community! And we have suffered for it.

We began as individuals to take the water out of the streams and by reasons of beginning as individuals we multiplied the priorities. We did that on the Spanish Fork River, on the Provo River, on the American Fork Creek,—and you might speak about all those numerous streams, big and little, that come down into the desert from the great Wasatch Mountains from Cache Valley on the north down to the St. George country on the south. The first individuals who went in there and developed the country had a large water right; the ones who came after had a small water right; and the tertiary ones had just what they could steal.

Then there came a time when it became necessary in the interest of economy to distribute the waters, to get a higher duty out of them. It became apparent that would have to be done, and they organized into corporations. Many of these ditches had been used by tenants in common, by a sort of partnership arrangement, the owners would get out in the spring of the year and clean out the ditches. Now the brethren were persuaded to get together and counseled to get together, and when communities in Utah years ago were counseled to get together, they got together, (Laughter)—and organizations were formed and in the course

of a few years it turned out that the fellow who had the original primary right, who was there first, and who could have held under any interpretation of priority and property rights, a full water right for all the acreage that he had, in the middle of the summer, found himself with only half a water right;—because he had joined that corporation. Don't you suppose that got under their hides? You bet it did. It was a glorious thing for the fellow who had only a half water right, or the fellow who heretofore had been stealing what he had; it was a hard thing for those who had been on the stream first and who had to part with some of their property.

That comes back to the thing here, as to the general good; it justified itself. But when you justify a thing by injuring somebody, the injured parties do not readily forget it. They always shy when you bring up something new. An agricultural community that has been pinched by going into a new organization is mighty shy of going into any new proposition; and this is true whether it is the fellow who had the tertiary water right or the primary water right, for the fellow who had the primary water right knows that he suffered before and the fellow who has the last and least water right on the creek knows that he was a big beneficiary by the new arrangement and he does not want to part with any of his advantages by following further the path of general good.

That is one spirit that has been developed in this State. Now, I do not say that that has been universal. I do not know but that my friend, F. D. Moore, who sits here on my right, can remember the time, and it is a historic fact, that Payson had one square mile of territory under irrigation. They had a community of certain size; they had reached the limit, as they thought, and as they understood and as they used the property, of the ability of Petutnut Creek; but still Payson was not as big as it ought to be. And so they gathered all the people together; new men were coming in by ox teams or by shank ponies, passing through, passing through, and they wished some of them would stop there and build a larger community so they would have more property to tax, so there would be more interchange of community life, so they could build bigger tabernacles and have more business, and they voted in that meeting to extend Petutnut water over a half section of land more and invited new people in. That has been also indicative of the character of development that has taken place in this State. Any system of pinching somebody to develop advantages to others. That sort of thing, however excellent for the public good, has made us, generally speaking, very conservative about unification of the established systems that we have upon our streams, particularly as to those who are, or appear to be, situated advantageously in the existing scheme; and I believe the greater the equality the more difficult it is to shake the old scheme down. It is a good deal like cement; the older it gets, the harder it gets, and some of it has to be blown up with dynamite. So, in the interest of the general good, I presume we will have to be shaken pretty severely in order to get away from some of our organizations that are not the most advantageous for the general community welfare.

The United States Reclamation Service, to be specific and to leave the general statement, began in about the year 1905 to speak to the people definitely about carrying forward the purposes of the Reclamation Act in the State of Utah. The government had spent a good many years in investigation and there had been organized state assistance by means of what was called the Utah Arid Land Reclamation Fund Commission, created for the purpose of getting our statutory provisions in harmony with the requirements of the government in order that we might get

Federal aid here in Utah. We were willing to do everything. It was a good deal like it is in conference. The brethren come down and say what our ideals are, what we desire, expand our love, speak about the great things that we are attached to in a material way, and then we all stand upon our feet and vote in the affirmative, because it **does not cost** us anything. But as soon as it begins to cost us something, we develop a tremendous amount of conservatism.

So it was about the business of the government arid land reclamation. As long as we did not know whether it was going to cost us anything or not there was a very aggressive spirit in every one of the districts where an investigation had been taking place for the purpose of getting Federal aid.

This is just historic, but it is illustrative: Three projects of primary importance had been investigated by the United States: the Utah Lake Project, the Weber River Project, and the Strawberry Valley Project. Now at the crisis around the table sat the men upon whose decision rested where the Federal government's money should go. So they called in either first or second,—I would not be sure—the brethren from Utah Lake. Everybody in Utah who had heard Mr. Newell speak, from the time the thing started until the last word was said, knew what was required. The delegation served from Utah Lake came. They were advised that the only way to get the government in was for the watermen to get together to have a unit organization. But this unit organization could not get it in the Utah Lake district; the people themselves through their representatives, turned it down. Government investigation on the Weber River showed there was a tremendous opportunity for storage and extension of irrigation and reclamation here. Some of your leading men of the counties in the Weber drainage area, carrying in their hands the decision of the matter, met around the table with the government representatives. These Utah men with the great possibilities of the Weber at stake, told the United States Government that they not only could not get together, but they would not get together,—a manifestation of ultra conservatism fearful to behold.

There was one thing left in Utah that the government had been investigating; the Strawberry project, and that project involved years of toil before any beneficial use could be made of the water. On the Spanish Fork River the people had had an experience like Jacob had in Palestine. They had been pretty nearly dried up out of existence so that they were forced to go to the land of Egypt, so to speak, to get something to carry them through the drought. They had twenty-five thousand acres of land under some kind of irrigation, and I have measured that stream many times between 1900 and 1903 when it ran less than forty-second feet of water at the mouth of the canyon, and there were great losses in carrying the water from that point down to the lands they were attempting to irrigate with it. Those men were in the very throes of disaster, and the Federal representative could not ask these men a question but that they to the last man voted unanimously every time that they would do or would attempt to do anything that was required. The spirit, Mr. Davis said, was "We dare you to ask us something that we will not promise to do in order to get that water." (Laughter). And the government went in there and built a project. They all signed up and said they would get together and make a unit organization. We have democratic ways of doing things and imperial ways of doing things. Now, the imperial system is to lay the foundation very carefully, and then proceed to do the job. The democratic way is to start in to do the job, and make the organization as you go along. (Laughter and applause). And, of course,

they had more or less things happening, as the matter proceeded, that did not pass muster in Washington, and they had to back up and start it all over again; and in the backing up process and doing it over again that old conservatism reasserted itself. Conditions had been tempered; the rains had fallen; the snows had come, the land had been revived, crops were more plentiful, and then the disposition of the people was to hold on to those sacred institutions that they had before. And when they found that the first signing up was not a definite signing up, that was conclusive; they sort of backed up, and we have there under actual operation today a lot of corporate units under a sort of contractual relationship with the United States buying storage water, in which the company stands as a sort of intermediary between the United States and the actual land owner.

Some of these gentlemen have said here today there ought to be unification and all this sort of thing. As soon as you can prove to the farmer in the Spanish Fork district that it is going to cost him less when he gets into this unification, I think he will go, but the old Utah system there is not spending as much money per acre foot of water as the unification is, and as long as that condition exists the economic tendency will not be toward unification.

Now, I want to revert to an instance where considerable unification took place when the matter was somewhat inchoate. The Indian Reservation was opened in 1905. The United States government immediately upon the opening of the reservation began to spend great sums of money for the purpose of conducting water to the Indian lands which were of great area and very fertile lands, interspersed with the blocks of Indian land were areas that were open to the operation of the public land laws of the United States, by homestead, and so forth, on payment to the Indian Department of practically the same amount of money, or a little more, than our ordinary homestead laws required. All of you remember about that opening and the furore that it created in the State and in the nation. People went out there and settled. Canals miles in length were built to various sections of land, from the Duchesne River on the south of the Uintah slope up to the head of the benches that lead to the foot of the Uintahs, covering areas which are fertile and irrigable over a distance north and south of something like thirty-five or forty miles, and much greater in extent east and west, being as you see, a magnificent country in extent. Mr. McGonagle has said in the State of Utah there are about one million acres of land under irrigation. In the Uintah country, there are, I presume, more than six hundred thousand acres, so you see, it is an empire over there.

The settlers had taken their lands under the homestead law. Four or five neighbors would get together and make application for water; sometimes an irrigation company, having a thousand acres or so would be organized. There were many organizations of that kind that were formed. There was in the beginning, no demand for unification at all.

There were some of our brethren who desired that Utah people should obtain some of the lands over there, and an organization was formed for the purpose of communicating with them, working with them, acting with them, in order to aid in the acquiring of one hundred and sixty acres of land in the Duchesne Basin by such citizens. The organization was then known as the Wasatch Development Company. In the beginning, the Wasatch Development Company filed applications for large volumes of water at what you might call critical places, where large diversions could be made. Our law provided, and it is the same today, that in a circumstance of that kind any land owner whose land lay within the area of the

applications of the Wasatch Development Company could make his own individual water filing. Such water right would not be quite so good as the earlier filing since it would be subsequent in time. It remains though certain the land owner could be independent if he wanted.

It is the ordinary experience that if you will give a man his choice between a short ditch and an inferior right, or a long ditch, or a corporate ditch and a superior water right, chances are about two to one that he will take the short ditch and the inferior water right, because the immediate advantage appeals to him. In other words, he gets to use the water before these large projects are carried to completion.

Before the settlers could irrigate any of their small holdings, the United States had been busy there; they had spent hundreds of thousands of dollars in construction. The Indians were not doing anything in Utah, and the white men were on those ditches, or near these ditches. The settlers asked Mr. Means, who was then constructing engineer, and Mr. Code, who was then Chief Engineer of the Indian Service, why they could not use those ditches. A water ditch is a thing that is cheaper to the fellow who maintains it, to use it than not to use it. There was every inducement to get a little money, or a little cleaning, or a little attention from the white men who were there, and let them use those Indian ditches, but anybody who does business with the United States Government knows that there is a great deal of red tape and it is pretty hard to have the red tape unwound. In order to be acceptable, some sort of organization would have to be formed. The Wasatch Development Company had large filings that were recognized as being of prior right upon the stream if they were protected. The individual white man being unable to get the use of the government canals without entering into some sort of an organization, really was the coercing thing that led to the unification of practically all of that territory irrigated from the Uintah and Lake Fork rivers. The result of that economic pressure led the people to organize into the Dry Gulch Irrigation Company, in which and under which they could do business with the United States government and get the use of the Indian ditches temporarily until they built their own. In that corporation they preserved a separate independency for each separate ditch, each ditch was a unit to itself, a sort of district within the corporation. But all those several ditches and all that large body of land, in the neighborhood of one hundred and fifty thousand acres, operated under the Dry Gulch Irrigation Company, were to the vast advantage of all of the people who are in that organization.

The people, except for the general expenses of the corporation, were assessed for no other purpose than for benefits coming to their immediate sections,—such practical result being particularly in harmony with what has been said here as to the purpose of the district law, that you do not have to pay anything unless you get some benefit. The system expressed by the Dry Gulch Irrigation Company, you see, did not spring from the spontaneous desire of the people; it was rather coercion that forced the people into that situation.

There is one other example which I want to mention here, and that is also a matter of practical coercion. In Castle Valley one of the principal streams coming out of the mountains is Huntington Creek. The country was settled there in the late '70's and ditches were taken out in the normal way, just as in the Weber and Ogden River districts. But this situation developed there:—the bottom lands were first cultivated, and as soon as the upper lands began to be cultivated seepage water began to come in heavily on the lower lands. Water-logging down in that

country is disastrous; water-logging is the enemy of prosperity. The whole lower end of that irrigation system was abandoned. Many of the earlier farms are white incrustations of salt that cover the surface so that you cannot see any soil. Here was a grave economic menace to every water holder or ditch owner; it was certain that he would have to move first here and then there. It was apparent that lower water rights would have to dig new ditches, or compromise or litigate their way into the upper ditches. Several canal companies, all of them diverting water from the river except the Cleveland Company, united together in the Huntington Irrigation Company. You can take a share of water right from one part of that system and you can change it anywhere you please into any ditch you please. That mobility of a water right leads to the highest value of water. You people are perfectly familiar with the fact that you may have a water right in certain areas and the water itself is not very valuable there, because there is a surplus, or for some other cogent reason; but you cannot change it into another or higher ditch because there is a strong antagonism between the ditch companies operating in the two areas. An acre water right in one ditch may be worth one hundred dollars, and in another ditch of the same character of water, from the same source, it may only be worth fifty dollars. That is obviated in the unification system on the Huntington Creek, and the water right is made so that it can go anywhere in the whole system. Such a system will allow the greatest mobility and the highest use of the water.

When you irrigate the upper part of a valley a great deal of seepage water comes out down below, where it can be used. It is plentiful there and the supply is continuous as seepage waters generally are, but you cannot very well change that water down below up to the head of the stream. That is your situation in districts like this. That was not the situation down there at Huntington because the seepage water ruined the lands and caused them to be abandoned. The people in the lower seeped tracts had to go up to the upper lands or seek new unseeped tracts in adjacent places in order to carry on the work of farming.

The greater the mobility of the water right, other things being equal and where it is not against the interests of the country, the better for the country. The more rigid you have it, without any interchange, without opportunity to let the water go to the place that gives the best economic use, the more disadvantageous it is to the country. Unification, as far as it can be justified by the economies that result from it, ought to be accepted and I believe the farmers generally will accept it where the demonstration is made to them that economy and higher use and better service does result from it. (Applause).

UNIVERSITY OF ILLINOIS LIBRARY
JUN 3 1921

PRESIDENT'S ANNUAL ADDRESS

By JOHN A. WIDTSON,

President University of Utah

A MAP OF UTAH'S FUTURE—IRRIGATION EXPANSION

Utah is an empire of undeveloped resources, only a part of which are known or explored. This is the determining fact in the mapping of Utah's future.

Were the vast resources of Utah all known, our small population would be able to develop only a few of them. After nearly three quarters of a century, Utah's population is so small as to allow nearly 150 acres of land to every man, woman, and child who claims citizenship within the State. Little State development can be expected, unless our population increases; and if we are to maintain our place among our neighbors, forging rapidly onward, we must hurry on our growth, both in development and population.

NEED AND CONDITIONS OF AGRICULTURAL SUCCESS

Any State, as a commonwealth, depends primarily upon its agriculture. Even states, essentially of a mining or manufacturing nature, foster the agricultural development of their lands and the accompanying rural civilization. This is particularly true of inland empires, like the great intermountain states of this country.

Successful agriculture, however, in turn depends upon markets, i. e., upon the presence of a large body of consumers to stabilize and to make vigorous the business end of the farmer's activities. More people, to consume the products of the farms, can best be won by Utah by the development of her manufacturing enterprises, i. e., by the conversion of her raw materials into manufactured products. It may well be laid down as a dictum that Utah's future depends on the correlative development of agriculture and manufacturing.

In Utah, successful agriculture depends on the practice of irrigation. True, the average rainfall of Utah, something more than 14 inches a year, is sufficient to make dry-farming successful in many localities, but experience has shown abundantly that under Utah conditions, dry-farming thrives only as an adjunct of irrigation. All agricultural operations in this State are primarily dependent upon the practice of irrigation. The map of Utah's future will remain sketchy or be well filled in, as irrigation languishes or progresses.

RECENT IRRIGATION GROWTH

In view of the tremendous importance of irrigation in the development of the State, it is remarkable to note the slow growth of irrigation during the last decade. Ten years ago the census reported over 999,000 acres of Utah land under irrigation; the State Engineer of today declared only a few days ago that the total irrigated area of Utah was in the neighborhood of one million acres.

It may be, of course, that some thousands of acres of water-logged lands have been removed from the irrigated statistics, and that the real

increase in irrigated acres is somewhat larger than indicated by these figures. However, with the best use of the available data, the increase has been almost imperceptible.

HOW TO SECURE IRRIGATION EXPANSION

The first question before those interested in Utah's future is: How may irrigation expansion within the State be secured? With probably twenty million acres of arable land in our total area of fifty-four million acres, a larger acreage under irrigation must somehow be secured.

At first thought, it would seem that by securing new sources of water our irrigation expansion must be secured. Sober second thought, however, convinces us that the better use of the water already on hand might also increase tremendously our irrigated area. In fact, the most direct method of securing irrigation expansion for the State of Utah is to make better use of the water already diverted from natural channels into irrigation canals.

THE BETTER USE OF WATER

During the last two decades much new knowledge has been acquired concerning the duty of water. There is yet much to be learned, but we know enough to make many definite statements. The duty of water in Utah is still too low. Many engineers, in private or state employment, still contend that upwards of thirty-six inches of water per annum should be allowed for the production of crops, when, in fact, crops thrive on one-half to one-third of this quantity of water.

During the late war, a convention of Utah irrigation leaders was held, composed chiefly of canal managers and men appointed by the courts to supervise large irrigation districts. These men, with little hesitation agreed that, even under present conditions, twenty-one inches a year might be amply sufficient for the production of the standard crops of Utah.

The notable work of the Utah Agricultural Experiment Station on the duty of water makes it certain that the great margin between the quantities actually used and those really needed by crops justifies the doctrine that by more scientific irrigation, the water already diverted by our present reservoirs and canals may be made to serve well twice as much land as is now being irrigated.

The possibility of doubling the irrigated area by the better use of our present irrigation water is certainly of such tremendous importance as to warrant a campaign of irrigation education or legislation in its favor. Yet, one must ruefully remark that Utah, the pioneer irrigation State, which has provided by legislative enactment for the technical qualifications of fruit tree inspectors, live stock inspectors, and other workers of like character, has not yet taken the trouble to set any standard of technical qualification for the water masters of this State, who have in their charge the very industrial life and full economic future of the State.

THE CONTROL OF SEEPAGE

By the diminution of the loss of water by seepage, the present water supply might also be made to serve much more land. From practically every canal in the whole State there are tremendous losses by seepage. Wherever a canal crosses a gravel streak, water is poured into low lying lands in quantities that would often suffice to build another large

irrigation system; and from every earthen canal there is constant, large seepage.

Some attempt has been made from the very beginning of irrigation practice in this State to reduce this seepage, but by methods mostly of a very primitive kind. Usually the natural silting of canals through the years has been relied upon as sufficient to prevent seepage. The very large and progressive waterlogging of the lower lying lands is an eloquent evidence of the insufficiency of the present methods of making canals watertight, and of the excessive use of water in irrigation.

However drastic and visionary the statement may seem at the present time, it is clear to any student of the subject, who has at heart the development of the State of Utah, that most of our irrigation canals must be made water tight by the use of cement or other means now known or that may be invented, if the waste of water by seepage is to be overcome.

The Weber and Davis Canal is already cement lined throughout a part of its course. The expense was great but the farmers have profited, greatly by the venture, for not only has the seepage been reduced, but the water formerly lost is now available for further irrigation. The government canals under the Strawberry project are also in part lined, especially in places where seepage threatened to become considerable.

The map of Utah's future will include a system of lined canals and laterals, permitting all the water not lost by evaporation to be applied on the land for the production of crops.

THE VALUE OF DRAINAGE

Closely allied to the prevention of seepage is the extension of drainage systems. Under the best methods of applying water to lands for agricultural purposes, it is probable that some water will always move downward beyond the reach of plant roots and connect with the standing water table to raise it and thus to water-log lower lying lands. Such lands should be drained; and in most cases, at least after the system has been in operation for some time, the drainage water may be used again for irrigation purposes.

The prevention of seepage, and the larger use of drainage for waterlogged lands may easily increase the present irrigated areas a fourth or a third without the building of another irrigation canal.

REORGANIZATION OF IRRIGATION SYSTEMS

The problem of the reorganization of the existing irrigation systems, which have gradually grown into their present shape and condition since the early days of the State, is also of first importance in our irrigation expansion. Mighty as Utah's irrigation lesson has been to the world, it originated humbly and under most adverse conditions. As the population grew, the small pioneer systems were enlarged and made to serve lands under new and larger conditions. Consequently many cramped and antiquated irrigation organizations exist here and there which need readjustment.

For instance, there are a number of parallel canals carrying water from the same source to almost adjacent lands. One such canal, enlarged a little, could easily be made to serve the purpose of the two now in operation, and in that way simplify exceedingly the management of the system and reduce considerably the cost of annual upkeep, which is always a considerable burden upon the irrigator.

In other cases, a number of smaller canals, not necessarily parallel, but each under independent management, serve a series of adjacent lands. If the management of these were consolidated, the cost would be less and the centralized authority would permit the rotation of water service to the farmers in the most effective way. In times of emergency, when the water supply runs low or special crops require special assistance, such centralized management could ordinarily save the crops and thereby serve the farmer's best interests.

Such reorganizations of existing irrigation systems are now being proposed in several localities in the State. Dr. Fortier, Chief of the Irrigation Investigations of the U. S. Department of Agriculture, is urging upon the farmers of Weber County just such irrigation reformation, which, if made effective, will be an excellent example for the other parts of the State. In an address before this Congress, Dr. Fortier stated it as his belief that by such a centralization of the management of the irrigation interests of Weber County, the water now running through the canals might be made to serve very nearly double the present irrigated area. The same thing would hold true no doubt for other sections of the State. By modern reorganization of the irrigation systems, therefore, there is a strong possibility that the irrigated area may be doubled without the building of another irrigation canal.

Before Utah's future can be safely provided for, the people of this State must be made to realize that by the more scientific use of water, the prevention of seepage, and the reorganization of existing irrigation systems, the water now serving one million acres of land within this State may be made to serve from two to three million acres. This is a subject worthy of the best consideration of our Legislature, and certainly there are few subjects, if any, in this State worthy of more careful thought among the citizens of Utah.

HOW TO INCREASE AVAILABLE SUPPLY OF IRRIGATION WATER

Moreover, there are great possibilities for increasing directly the available supply of irrigation water within the State. There are vast supplies of underground waters scarcely touched by the irrigator, and there is a large surface runoff not yet brought into irrigation canals.

Tremendous possibilities reside in the use of electric power for pumping water, both from sub-surface and surface sources; and there exist numerous opportunities for the building of reservoirs for storage and equalizing purposes.

The Utah Power and Light Company has within the last year demonstrated the possibility of increased service to the irrigation farmer by the equalizing opportunities possessed by its storage reservoir in Bear Lake.

LOST WATERS IN UTAH

For instance, the run-off at the mouths of streams within Utah contributing to the Colorado drainage system averages 17,195,000 acre feet a year. Of this, the engineers conservatively estimate that 6,000,000 acre feet may be used in Utah; and with a more heroic determination to build our State into its full possibilities, much more of this great run-off could no doubt be used. In any case, using the improperly large estimate of 36 inches a year for the production of crops, the part of the Colorado drainage within our State that may be used in Utah would reclaim 2,000,000 acres of land, or twice the present total irrigated

area, with a right good chance of increasing that acreage with the same water but under more modern practices, to three or four million acres.

Within the Great Basin a similar story is told. The average, annual run-off at the mouths of the streams contributing to Great Salt Lake and to other inland lakes amounts to 2,862,900 acre feet—sufficient to irrigate practically 1,000,000 acres of land under low duty, or double the present total irrigated area.

These figures, no matter how well one knows them, are startling. We stand before tomorrow with as great irrigation possibilities as awaited the Pioneers of '47.

Let us carry this examination just a step further. At Collinston, below the lowest canal, the run-off in 1917 was 1,990,000 acre feet, in 1918, 1,210,000 acre feet; and at Plain City in 1917, 999,000 acre feet, in 1918, 433,000 acre feet. That is, within easy reach of Ogden and Salt Lake City are wasted quantities of water annually that would, if used, make these valleys one continuous irrigated farm, making possible a tremendously larger and finer commonwealth than we have at the present time.

UTAH WITHOUT IRRIGATION

What would Utah be without irrigation? An inhospitable and unfruitful desert. Bands of sheep and herds of cattle might still range over its mountains and valleys; mines might be developed, but there would be here no State attractive to great numbers of people, producing coincidentally abundant wealth and human happiness, and making a high place for itself in a union of forward moving States. Go into the desert as it still remains, and note the mines and the sheep and cattle ranches, and you will come back with the conviction that without irrigation this would not be a good place in which to live!

UTAH WITH IRRIGATION

What has Utah become with irrigation? "Under the ditch" have arisen tens of thousands of farmsteads, gardens, wonderful in contrast with the surrounding bleak desert. Modern and comfortable towns and cities have been developed; men, reacting to a prosperous and beautiful environment, have taken courage and found pleasure in utilizing more greatly than were possible in the desert, the natural resources of the State, through mining and manufacturing; sheep and cattle ranching with the adjunct of irrigation has been perfected beyond any possible degree under desert conditions; the per capita wealth of the State is nearly \$1750. All this, if one will examine the problem in its details, has been derived, more or less directly, from irrigation. Elbert Hubbard saw all this when he tersely remarked that no people ever made money as fast as did the Utah pioneers as they built the first irrigation canals.

IRRIGATION A PUBLIC NECESSITY

Irrigation in an arid country must be placed on a par with other great public necessities like education and the preservation of health, and should not be looked upon merely in terms of the direct return of the investment in reservoirs and canals. Where a State depends for its very existence upon a practice, that practice should be accepted more and more as a State concern. An example or two may emphasize this thought.

Under the irrigation canal, the valuation of the property within the

State of Utah is approximately \$700,000,000. This capital produces vast sums. Its 25,000 farms produced in 1919, a poor year, more than \$75,000,000. The manufacturing products during that same period were valued at more than \$150,000,000. Other State industries prospered in like proportion. Whatever may have been the cost of the canals that made all this possible, it is rendering a royal tribute to the present generation.

This State valuation included not only the agricultural lands and improvements, but all of the property within the State. It may be of interest, therefore, to consider a more specific instance of the effects of irrigation.

About thirty years ago, the Bear River canals were constructed to convey water from Bear River in the Narrows between Cache and Box Elder Counties to an area of desert land in Box Elder County. The system cost about \$1,250,000, according to the findings of Dr. George Thomas in his forthcoming book on Irrigation Institutions. It seemed impossible at that time to make the project a financial success, and after much tribulation, the investors lost most of their money. The canals were at length sold to the Utah-Idaho Sugar Company for about \$300,000. The company improved the system at an expense of perhaps another million dollars. Steady development has gone on since that time. Within the system are no mines. Its prosperity depends upon its agriculture and attendant industries, as made possible by the water supplied by the canals. Note, now, how the failure of thirty years ago has been converted into success! In 1919, the assessed valuation of the lands and properties vitalized by the Bear River canals is \$25,291,159, or approximately 1/28 of the total valuation of the State of Utah! If the State of Utah paid back every dollar lost by the original investors, it would still be a tremendous gainer. Industrial development under the canals has only begun, as it were, and will continue for generations. Without the canals the land would be a sagebrush waste, capable at best of supporting a little livestock or permitting some dry-farming.

Comment on the value of irrigation in such a case seems quite superfluous. Certainly it is worth while for the State to give its first and most vigorous attention to the extension of its irrigated area.

METHODS OF SECURING IRRIGATION EXPANSION

How is all the irrigation expansion demanded by Utah's future to be accomplished? First of all by the education of the people into a full understanding of the necessity and possibilities of irrigation; followed by wise legislative action to point out the path that the people must travel if they are to lay more broadly the irrigation foundations of the State.

Then, business and professional men, who after all derive their existence from a commonwealth based essentially upon irrigation, must unitedly insist, even at their own temporary sacrifice, that forward irrigation steps be taken, and that by education and legislation, Utah's irrigated area be increased, even if it must be at the State's expense. It must be a community, a State affair, because the existence and future of the State depend on it.

INCREASING COST OF WATER

Whenever the increase of available irrigation water by new reservoirs, dams, and canals is discussed, the question of the final acre cost of the

water invariably arises. Naturally, when Utah was young the most accessible streams and locations were used for irrigation purposes, and the more difficult projects left for later times. As the value of lands has increased, it has been possible, and may continue for some time to be possible, to take out water at an increasingly greater acre cost. Nevertheless, the acre cost of water will increase steadily as the more difficult projects are approached. There will come a time when it may cost \$200 to put water on an acre of land which has a market value of only \$175. As we approach that time, irrigation will become more and more the business of statesmen and less the business of those who have been trained to look upon the affairs of life in terms of immediate and annual return on their investment.

It may become necessary at that time to make the State the irrigation unit, and to average the acre costs among the various projects undertaken by the State, so that a farmer shall not be penalized for undertaking to develop a part of the State which is more difficult of conquest than is another. The time is near at hand when the State must make the development of irrigation projects a State affair; and in view of the tremendous returns in valuation, in annual direct income to its citizens, and in the possible development of all manner of industrial enterprises wherever an irrigated community arises, the State cannot and will not hesitate to give such needed aid.

The experience of the federal government in this matter is of interest. Congress began its work of reclamation by irrigation on the assumption that the projects should return the capital invested and pay a fair annual interest from the beginning. In short the reclamation fund would steadily grow. As the years go on, that hope is becoming more and more remote. Meanwhile, on the reclamation projects are being established prosperous communities producing millions in crops, making possible far reaching industries; and no one complains because a part of the money used by the federal government for the reclamation of the arid region may not be returned directly, but will be paid back indirectly in taxes and in the general increased prosperity of the arid section.

IRRIGATION AND THE MAP OF UTAH'S FUTURE

The statesmen who shall fill in the outline map of Utah's future will be obliged to make the State's irrigation expansion one of their chief concerns, and the professional and business men of this State will not hesitate when the time comes to use State moneys for the development of irrigation enterprises to allow a part of their taxes to be used for this purpose.

Dr. Samuel Fortier delivered an illustrated lecture on irrigation, but before doing so, made some brief references to the topic of the morning, viz., Irrigation Reconstruction in Weber County, Utah, and the organization of an irrigation district. In the course of these remarks he said:

"Thirty years ago, I came to this State from Denver, Colorado, to build the present system of water works for this city,

and ever since I have been interested in your welfare and have longed to help you formulate some plan of irrigation development that would benefit not only this generation but succeeding generations.

In the plans that we have been discussing today and in the methods of procedure which have been outlined, I fear you will not go far enough. You wish to provide more water for irrigation by means of storage reservoirs, but on the other hand you are unwilling to abandon many of the small canal systems by merging them into a few large effective systems. I can perhaps bring home to you the thought I have in mind by comparing irrigation canals with roads. Imagine that there are five dirt roads between Ogden and Salt Lake cities and all in poor condition. Now if the Highway Commission of Utah were empowered to improve these roads, what course should it follow? Should it attempt to pave all five or abandon four and put all the available money into one? You intend to store water at high cost and distribute it through a large number of poorly built canals and thus continue the water-logging of valuable lands. In case an irrigation district is formed in this county, I wish to go on record as favoring at an early date after organization an equitable appraisal of all water rights within the district and a transfer of these rights to the district itself, the owners to receive district bonds in exchange for their water rights.

It is important to consider that not only more water is needed for Weber County but that the large majority of the canals and ditches now in use should be overhauled, merged into a few large systems and more or less completely reconstructed. You need a central organization for the storage of water and you need the same kind of an organization in order to reconstruct existing systems. By providing at an early stage of the undertaking adequate spurs, railroad tracks, warehouses, yards and shops, a large amount of money might be saved to the district. A large amount of concrete pipe is likely to be needed and this should be made in some central yard and shipped to the place of use. In like manner over a thousand headgates may be required and these also should be standardized, made in yards and transported to the place of installation.

I am making these brief references, gentlemen, to show you that there are advantages to be gained by this proposed organization other than the storage of water. It seems to me that if

you organize, build your storage reservoirs and stop there, that you will not be utilizing to the fullest extent possible the opportunities which lie within your grasp.

Followed by an illustrated lecture.

INTERPRETATION OF LAWS CONTROLLING THE USE OF GROUND WATER, WITH SPECIAL REFERENCE TO WATER DEVELOPED BY CONSTRUCTION OF DRAINAGE SYSTEMS

By JUDGE S. R. THURMAN

The subject of my remarks as framed by the committee who requested me to address you this morning is, "The interpretation of laws controlling the use of underground water, with special reference to water developed by construction of drainage systems." I am flattered by the compliment paid me by this invitation and only regret my inability to do justice to the subject.

Questions relating to right to the use of underground waters are always of more than ordinary interest to people residing in the arid regions. This interest has been intensified in recent years by the growing necessity of draining mining property in the course of its development, and of farms that have become saturated and swampy from irrigation. In the very nature of things, questions relating to this subject will in the future for many years to come occupy the attention of courts and legislatures to a far greater extent than they have heretofore.

The right of a proprietor to drain his mine so that he can profitably continue his mining operations or of the farmer to drain his farm in order to render it productive cannot be seriously questioned as long as he does not thereby injure his fellow man. And even when injury results, if the injury be merely incidental, without negligence, malice or design, he cannot ordinarily be held to respond in damages because, as declared by the law, it is "damnum absque injuria."

This, in the very nature of things, is a self-evident proposition. If the mining operator or farmer is prohibited from draining his mine or farm in cases where his property is practically valueless without it, simply because his neighbor may be incidentally injured thereby, it in effect, amounts to a condemnation of his property for the benefit of others without just compensation. While it must be conceded that every man has the right to drain his land to render it more productive, whether it be a mine or a farm, the vital question is: To whom does the beneficial use of the water belong—the mine owner, the farmer, or some one else? These are the questions that must, and will, occupy the attention of the courts until every possible phase of the question has been judicially determined by a court of last resort.

It is not my intention in this address to attempt an elaborate analysis of the conflicting views of courts and jurists relating to the common

law doctrine pertaining to rights to underground waters, as compared with the doctrine of appropriation which must of necessity prevail in the arid region. The difference between the two is as marked as the difference between day and night or the difference between the precipitation of moisture from the clouds upon the land beneath and the conducting of water thereon by artificial means for irrigation.

I assume it will be of most practical benefit to the members of the Congress and others who may feel a special interest in the subject, if I limit myself to an interpretation of the law as the same has been determined by the courts of our own State. Any departure from this line of thought on my part will be for the sole purpose of illustrating the fundamental difference between the two doctrines to which I have referred.

THE COMMON LAW

At common law the owner of the land owned the percolating water beneath the surface. He also owned the water flowing in subterranean channels unless the channels were known and well-defined. If they were known and well-defined, the use of the water belonged to him who had appropriated it and put it to a beneficial use. This, in brief, is the doctrine of the common law concerning under ground water. It had its origin in countries where the rainfall and other forms of precipitation throughout the crop-growing season were ordinarily sufficient to mature crops. It is wholly inapplicable to an arid region such as ours where the rainfall is insufficient, and the farmer is absolutely dependent upon artificial irrigation. The stream upon which the farmer relies for irrigation ordinarily has its source in lands other than his own. These streams, in most cases, have their sources in underground percolating waters which eventually find their way to the surface. If the owner of the land can at his pleasure by tunneling, draining, digging wells, or by other forms of excavation, claim the water developed by these means and thereby dry up the streams appropriated by others, it will only be a question of time when the farmer, the gardner and horticulturalist will be deprived of their occupation and ordinary means of living. We may go further and say that the same rule that would deprive these classes of our population of what they supposed were absolute vested rights to the use of water for the purposes mentioned would also deprive them and others of water for domestic purposes, for the common law makes no distinction. It is perhaps unnecessary to say that a rule that would result in such consequences can never be the law of this commonwealth. The same is true with respect to other states similarly situated in the arid region.

THE LAW OF APPROPRIATION

On the other hand, the law by which we are governed in respect to the ownership of underground water, whether the same is found percolating or flowing in subterranean channels, is the same as that which pertains to water flowing or existing on the surface. It is known as the law of appropriation, the basic principle of which is, "first in time, first in right." This law had its origin in the local customs adopted in California in its early settlement. The same customs were adopted by other states and territories similarly situated, including the Territory of Utah. The custom thus established was recognized and confirmed by an Act of Congress in 1866, which, among other things, provided that "whenever

by priority of possession, rights to the use of water for mining, manufacturing or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws and decisions of courts, the possessors and owners of such vested rights shall be maintained and protected in the same."

Afterwards, in 1870, another law in harmony with this was enacted by Congress providing that all patents issued, or homesteads or pre-emptions allowed, should be subject to such water rights and rights to ditches and reservoirs used in connection therewith.

While the law of 1866 by its terms strictly construed seemed to be a mere recognition and confirmation of rights which had theretofore been acquired, yet by a long and unbroken line of decisions by the courts in the regions affected and by the Supreme Court of the United States, the law was held to apply to rights acquired thereafter as well as those acquired before.

It will be observed that neither the law of 1866 nor the law of 1870, to which I have referred, makes any distinction whatever as between water flowing or existing on the surface and subterranean waters whether the same be found percolating through the soil or flowing in known and well-defined channels. So that if we consider this question in the light of these Congressional enactments alone, uninfluenced by judicial interpretation, we are bound to arrive at the conclusion that the Government of the United States, the sole proprietor of the public domain, having the power to dispose of it as it saw fit, did, by the enactments referred to, in effect abolish the common-law as it had existed theretofore in respect to both surface and underground waters on the public domain. The doctrine of riparian rights recognized at common-law, by which it was held that the owner of land abutting upon a river or stream was entitled to have the same flow as it was wont to flow undiminished in quantity and underteriorated in quality, as well as the doctrine that percolating waters belong to the owners of the soil, were effectually abrogated by these Acts of Congress whenever they came in conflict with the law of appropriation. Especially was this true as to rights acquired after the passage of the Acts.

LOCAL LEGISLATION AND COURT DECISION

In conformity with these Acts of Congress our own legislature, in 1880, enacted a law recognizing the principle of "first in time, first in right," thereby giving legislative sanction to the principle of acquiring rights to the use of water by appropriation. The act is in direct conflict with the common-law doctrine concerning rights to the use of water whether found above or below the surface.

THE STOWELL v. JOHNSON CASE

It has been held by the Supreme Court of Utah, in a case arising in this judicial district, that the doctrine of the common-law concerning riparian rights never was the law of Utah, and that the statute of Utah above referred to was valid and in force even as against a riparian right alleged to have vested and accrued prior to the passage of the act. (Stowell v. Johnson, 7 Utah 215).

The common-law doctrine of riparian rights is not necessarily germane to the subject now before the Congress. I refer to it, however, because it is too closely connected with the common-law doctrine relating to underground waters to be ignored. One doctrine is substantially a

corollary of the other. In one case the owner of the soil claims the right to have all the waters of the stream flow by or through his premises as it had flowed from time immemorial; in the other case the owner of the soil claims ownership of all the percolating waters beneath the surface of his land and all other waters therein not flowing in known and well-defined channels. In both cases the right is claimed as a part of the soil and not as a mere easement or appurtenance. Both are utterly inconsistent and incompatible with the law of appropriation and conditions dependent upon artificial irrigation. It is impossible to conceive that the common-law doctrine in either case can be admitted in the arid region whenever it comes in conflict with the law of appropriation.

THE SULLIVAN CASE

We have seen that as far as the doctrine of riparian rights in Utah is concerned the question was adjudicated in *Stowell v. Johnson*, to which reference has been made. I now call your attention to a Utah case in which the rights to the use of underground water was involved; that of *Sullivan v. Northern Spy Mining Co.*, 11 Utah 438. Here we have a clean cut case in which the doctrine of the common-law as to percolating waters is brought squarely in conflict with a right claimed under the law of appropriation. In this case the predecessors of Sullivan had dug a well upon the public domain which well was supplied with water by percolation. The owners of the well used it for many years for domestic and culinary purposes. Later on the mining company located the land under the mining law of the United States and afterwards procured patent. Having procured its patent it set up a claim to the water of the well and sought to deprive Sullivan of its use. Its claim was based entirely on the common-law doctrine that to the owner of the soil belongs the water percolating therein. Sullivan based his claim upon the law of appropriation, "first in time, first in right." He rested on the Act of Congress of 1866 to which I have referred, contending that by virtue of that Act he had the right to enter upon the public domain and appropriate water. He also invoked the Act of Congress of 1870 to which reference has also been made and in which it is provided that patents issued thereafter were subject to water rights previously acquired. Our supreme court sustained his contention and affirmed the judgment which had been rendered in his favor in the court below. This opinion of the court, which is one of the most important that has ever been rendered by our supreme court, is marred by a dictum near the close which has caused some confusion in later decisions. The learned justice, after stating the law of appropriation in brief and admirable form, declaring in favor of the appropriator as against the owner of the land, went out of his way to suggest that the right of the appropriator was subject to the rule of law which would permit the owner of the land to sink an adjoining well on his own premises even though he should dry up the well of the appropriator. No such question was before the court, and consequently the suggestion has no weight whatever as authority upon the question involved. The court, in a recent decision, had occasion to review the opinion in the Sullivan case and characterized the suggestion referred to as *abiter dictum*. (*Stookey v. Green*, 178 Pac. 586). I mention this fact in order that the reader of that opinion may not be misled as others have been by a fugitive expression having no force or effect whatever as authority. Neither of these cases have been modified or overruled by later decisions. They are both judicial interpretations of statutes in

force when the decisions were rendered. In my opinion there can be no question as to their meaning, force and effect. The first declares that the common-law doctrine of riparian rights never had any force in the Territory of Utah; the second declares, in effect, that the common-law doctrine that percolating water belongs to the owner of the land has no force or effect as against one who establishes a right by prior appropriation. When I say a right by prior appropriation I must be understood as meaning the taking of water which has its source on the public domain, for as yet we have no decision of our court or statutory authority for attempting an appropriation of water which has its original source on the private lands of another.

THE WILLOW CREEK AND OTHER CASES

Our supreme court, in at least one case, has held that such an appropriation cannot be made as against the owner of the land. The case referred to is Willow Creek Irrigation Co. v. Michaelson, 21 Utah 248. In that case the plaintiff was an irrigation company and had appropriated the waters of a stream known as Willow Creek, in Sanpete County. In the year 1891 the United States conveyed to Michaelson a certain tract of land in the vicinity of the creek and issued to her a patent therefor. After she had procured her patent, water appeared on the land from natural causes, forming a bog or marsh. The water increased in quantity until 1895 when it began to flow in a stream through a natural depression into the creek appropriated by plaintiff, from which it was thereafter used by plaintiff together with the other waters of the Creek. After its use by plaintiff for several years, defendant erected a dam across the depression, diverted the water away from plaintiff and commenced to use it upon her own land. Plaintiff based its right upon the law of appropriation; defendant on the common-law doctrine—to the owner of the land belongs the water percolating therein. It was admitted that the water rose upon the land by percolation. The district court found in favor of defendant, and the supreme court affirmed the judgment.

The fundamental difference between the facts of that case and those of the Sullivan case is that Sullivan, or his predecessors in interest, dug the well and appropriated the water on the public domain; while in the Willow Creek case no attempt was made to appropriate the water until after a patent was issued for the land upon which the water arose. In fact, there were no visible water to appropriate until years after the patent was issued. The doctrine of that case has not been modified or overruled. It simply goes to the point that water having its original source on private land is not the subject of appropriation as against the owner of the land. To the same effect, to a certain extent, is the case of the Crescent Mining Company v. Silver King Mining Company, 17 Utah 444. It is not necessary to specifically review the case. It simply sustains the right of the owner of the land to the percolating water therein as against one who subsequently tries to appropriate it. See also Peterson v. Eureka Hill Mining Co., 176 Pac. 729. Where an appropriation is made before the land is reduced to private ownership the appropriation will be sustained even as against the owner of the land. This, I believe, is the law of this State at the present time as the same has been judicially determined by our court of last resort.

THE MOUNTAIN LAKE CASE

A more recent decision involving the law of underground waters is that of the Mountain Lake Mining Company v. Midway Irrigation

Company, et al., 47 Utah 346. In that case, however, the common-law doctrine was not invoked. The Mining Company, for the purpose of developing and draining its mine drove a tunnel for a distance of about one mile into its mining ground near the headquarters of Snake Creek, in Wasatch county. Snake Creek and its tributaries for more than a generation before had all been appropriated by the defendant company and other inhabitants of the town of Midway. The tunnel driven by the mining company collected a large quantity of water, the greater portion of which the mining company claimed as "developed water." The defendants, on the other hand, claimed it all by prior appropriation. It contended that the underground water developed or collected by means of the tunnel were the real sources of Snake Creek and its tributaries and therefore subject to their prior appropriation. Our supreme court not only sustained the irrigation company's contention but under the peculiar facts of that case held that the burden was upon the mining company to prove that the waters it claimed were no part of the waters of Snake Creek appropriated by defendants rather than upon the defendants to prove the identity of the water in dispute.

It is not contended that the Mountain Lake case is specially germane to the subject-matter of this discussion. It involved no question of conflict between the doctrine of the common-law and the law of appropriation. It is a case, however, in **which rights to underground waters** are involved and demonstrates the extent to which our courts have gone to uphold and sustain rights acquired under the law of appropriation. To the same effect see *Bastian v. Nebeker*, 49 Utah 390.

CONCLUSION DRAWN FROM THE FOREGOING CASES

The cases reviewed, except the first which relates to surface water and riparian rights, are all cases involving the right to underground waters. From the review we have made, one proposition, at least, has been established, and that is the most important and far-reaching question involved in this discussion—the right of the owner of the land to the water therein, whether the same be percolating or flowing in channels, is subject to, and in all cases must yield, to the right of him who appropriated the same when the land upon which the water arose was part of the public domain. His rights are protected first by the laws of Congress to which we have referred; second, by laws enacted by our own legislature; and third, by the solemn decisions of our courts of last resort.

SNAKE CREEK TUNNEL CASE

The Federal Court of the District of Utah has recently held contrary to these views basing its conclusions upon what I believe to be an erroneous conception of the meaning and effect of the decisions of our supreme court. The learned judge of the Federal District Court of Utah is generally recognized as one of the best lawyers in the state, and in his opinion recognizes that it is his duty to follow the decisions of the state court on questions of this kind. His opinion seems to sustain the common-law doctrine relating to underground waters as against the right of a prior appropriator of the same water appropriated on the surface. In doing so, if I understand his opinion, he claims as authority the decisions of our supreme court, many of which I have reviewed. If the doctrine enunciated in the *Sullivan* case, which I have reviewed at length, has ever been modified, changed or overruled by any later decision, except as to

the obiter dictum hereinbefore considered, I have never read it and I believe I am familiar with every Utah case relating to this question. As long as the rule laid down in the Sullivan case is permitted to stand as a correct interpretation of the law, the rights of prior appropriators of water on the public domain, under the law of appropriation, must and will prevail as against him who subsequently patents the land and bases his right on the common-law.

The Federal case referred to is that of the Snake Creek Tunnel Company v. Midway Irrigation Company, substantially similar in its facts to those of the Mountain Lake case to which I have already called your attention. The only substantial difference relates to the form of action. In the Mountain Lake case the mining company claimed only the right to the new water it developed, while in the Snake Creek Tunnel case the tunnel company claimed all the water collected in its tunnel under and by virtue of the common-law relating to underground waters. The case is now an appeal in the Circuit Court of the United States.

THE HERRIMAN CASE

In Herriman Irrigation Co. v. Keel, 25 Utah 96, each of the Supreme Court Justices rendered a separate opinion. It is a case in which a mining company drove a tunnel which it was claimed dried up a stream previously appropriated by plaintiff. Mr. Justice Barch held rigidly to the common-law and denied the plaintiff relief. Mr. Justice Baskin based his opinion on the law of appropriation and held that the plaintiff was entitled to all the water it had been deprived of by means of the tunnel. Mr. Justice Miner took a middle ground and held that each party was entitled to half of the water in dispute. The contest seems to have been a draw and the result a judicial straddle. The case as a whole sheds no light on the important questions we are here to consider.

THE ROBERTS-GRIBBLE CASE

I next call your attention to the case of Roberts v. Gribble, 43 Utah 441. The plaintiff was the owner of land near the mouth of the Sanpitch river in Sanpete county. He irrigated his land by water diverted from Sanpitch river. Defendant owned a tract of land higher up the stream which had become marshy and unproductive on account of the irrigation of the land itself and other lands in the immediate vicinity. In order to redeem the land and render it productive defendant installed a drainage system consisting of pipes driven into the land by means of which the water was raised to the surface and thence conveyed upon the same or other lands of defendant for irrigation. Defendant succeeded in draining his land but in doing so and using the water to irrigate his land he dried up the stream below and deprived plaintiff of the use thereof. The court below rendered judgment in favor of defendant and the supreme court affirmed the judgment. The court expressly held that the facts of the case came squarely within the rule announced in Garn v. Rollins, 41 Utah 260, and based its decision upon that ground. The point is also made that the water was seepage and percolating water arising from irrigation in the vicinity, and while it is not expressly so declared by the court there is a veiled suggestion in the opinion that because it was seepage arising from irrigation it was therefore not the subject of appropriation.

In Stookey v. Green, heretofore cited, the Supreme court had occasion to refer to the Gribble case and moralize to some extent upon its meaning

and effect. It is there held that if the Gribble case goes no further than the Garn-Rollins case upon which the court based its opinion, then the Gribble case rests upon a firm foundation. The rule laid down in the Garn-Rollins case simply goes to the question of the right of a person to recapture and use surface waste water arising from his own land as against one who attempts to claim the waste water by appropriation. The court decided in favor of the right to recapture and use the water by the person upon whose land it was wasted. This case is referred to only for the purpose of explaining the full scope and meaning of the court's opinion in the Gribble case. Otherwise, it has no relevancy to the question I am attempting to elucidate in these remarks.

COMMENT UPON THE CASES REVIEWED

In our consideration of these cases if we confine ourselves in each case to the particular questions in controversy and determine exactly what was before the court and what was actually decided, we will have no difficulty in arriving at the conclusion hereinbefore expressed that the common-law doctrine concerning underground waters has never been sanctioned by the courts of this state where it comes in conflict with the law of appropriation invoked by a prior appropriator of water on the public domain, whether the water appropriated is above or below the surface.

THE RASMUSSEN CASE

The last case I have to present for your consideration is, in my opinion, the most important decision rendered by our supreme court up to the present time concerning the right to underground waters, and is perhaps more far-reaching in its consequences than all the other cases combined. Besides this, it goes directly to the point upon which I am specially requested to address the Congress—namely, "The interpretation of the law with special reference to drainage systems."

If I understand the purpose of those who framed the subject for this address it was to ascertain the law as to the relative rights of those claiming water that may be collected by drains, wells, or other forms of excavation, upon farm land or other property.

The case to which I refer is one in which the opinion was handed down only a few days ago. It is entitled *Rasmussen v. Moroni Irrigation Company, et al.*, and comes from the District court of San Pete county.

Before entering upon the brief consideration I contemplate giving to this important case I desire to premise my remarks by a few general observations reflecting some of the reasons for the decision rendered in the Rasmussen case.

Nearly every valley of any considerable area in the State of Utah has its stream or streams of water flowing from the higher to the lower levels having their sources in the hills or mountains by which the valley is surrounded. The lands of these valleys have nearly all been brought into cultivation, and the streams referred to diverted and applied thereon for irrigation and other beneficial purposes. In the beginning, and for many years thereafter, the water thus appropriated was entirely from the mountain streams having their sources in the precipitation which fell on the hills and mountains surrounding the valleys. Early in the history of nearly every valley there came a time when the inhabitants and users of water arrived at the conclusion that all the water had been appropriated and that the area of cultivation

could not be further extended. Every old settler in Utah will bear testimony to the truth of this assertion. Many instances could be brought to your attention in which the area of cultivation has been increased from three to six times beyond the supposed capacity of the stream. Even at this late date new land is being brought under cultivation and is being irrigated from streams, rights to which were supposed to be exhausted more than a quarter of a century ago. Probably, many reasons could be assigned for this apparent phenomenon. I need mention only two; the latter of which has direct bearing upon the principles involved in the Rasmussen case. The first reason for the supposed phenomenon to which I have referred is the fact that it requires many years of irrigation upon the arid lands of the desert to fill up the interstices of the soil and establish a level of ground-water below which irrigation of course is not required. Until this occurs it is practically self-evident that the farmer must depend entirely upon water from the melting snow and other forms of precipitation. After this, however, springs begin to appear in the lower portions of the valley. These find their way into the original streams and augment their flow. Seepage appears along the banks of the streams. Much of the land becomes saturated and swampy and is no longer dependent upon regular turns of irrigation. In fact, as years go on much of the land in the lower parts of the valley become too boggy for the production of crops and drainage becomes an absolute necessity. At this point we cast our eye over the area in cultivation and find to our surprise, as I suggested before, there are many times as much land in cultivation as there was near the beginning when the original appropriators thought the limit of the stream's capacity had been reached. If at this point the farmer who made the first ditch, diverted the first water and brought into cultivation the first farm and settled far down the stream, could analyze and determine the proximate source and character of the water he uses, he would perhaps find that instead of its being head water direct from the mountains as it was in the beginning, it is now water that has perhaps been used over and over again for irrigation by farmers situated upon a higher level. By means of this capacity for the multiplied use of water in the valleys of Utah, and of the entire arid region the farming population has been many times increased and the agricultural wealth of communities multiplied to almost an indefinite extent. I need only to refer to conditions existing in the valleys threaded by our most important rivers and streams. The Sevier river, rising in Garfield county, winding its way through Piute, Sevier, Sanpete, Juab and Millard counties is a notable instance; the Provo river, rising in Summit county, passing through Wasatch and into Utah county, its surplus water finally emptying into Utah Lake; the Sanpitch river, rising in Carbon and Sanpete counties, winding its way through Sanpete valley, and emptying at last in the Sevier river; the Weber River, Duchesne, Green, Grand, Rio Virgin, and many others, all belong to the same class, although the conditions described are not as pronounced as in the instances specifically mentioned.

In most cases rights to the use of the waters of these rivers have been adjudicated and titles thereto judicially determined. The distribution of the water has been based not alone upon the quantity of water coming from the mountains having its origin in the melting snows and precipitation on the higher levels, but the quantity awarded by judicial determination has included as well water from every source that finds its way into the stream. Seepage and run-off from irriga-

tion have greatly augmented the original flow and are of course included in the awards made by the courts. Most of the decisions rendered by the courts in recent years expressly provide that seepage and run-off from irrigation along the course of the stream are included in the quantity to be distributed. Such especially was the condition in Sanpete Valley along the course of the Sanpitch river including the irrigated lands east of the river in the vicinity of Rasmussen's land.

The plaintiff Rasmussen, in the case under review, is a farmer in Sanpete county. His land lies on the east side of the river and some distance therefrom, but within the area of irrigated lands the seepage and run-off from which eventually found its way into the river and substantially increased its flow. Rasmussen's land became saturated with water caused by irrigation in the vicinity from tributaries of the river. He conceived the idea of draining his land, which he had a perfect right to do, but he also conceived the idea of conducting the water drained from his land into the river, or a tributary thereof, and then divert therefrom a quantity equivalent to that turned in from his drain. He proposed to divert it from the river and convey it to other lands from which the seepage and run-off could not return to the river. This the defendants strenuously objected to on the grounds that they were the owners by prior appropriation and by a former decree of court of all the waters of Sanpitch river and its tributaries including the seepage and run-off from lands irrigated thereby. The case was tried by Hon. D. H. Morris, Judge of the Fifth Judicial District court, acting in the place of the regular judge of the District Court of Sanpete county. The court found in favor of the defendants. On appeal to the Supreme Court the judgment was affirmed.

The plaintiff Rasmussen while ostensibly relying on former decisions of the Utah court; in the last analysis, in fact relied upon the common-law doctrine to which we have so often referred. The logic of the opinion which was written by Mr. Justice Frick is, in my judgment, absolutely unassailable. It is stated in the opinion that it is in no manner in conflict with any former decision of this court which is at least an expression of the judicial mind to the effect, as heretofore stated, that the Utah court has never sanctioned the doctrine of the common-law as applied to underground waters. This is the position I have undertaken to assume from the beginning of these remarks down to the present moment.

COMMENT ON THE RASMUSSEN CASE

The decision in the Rasmussen case is absolutely just and is essential to the well-being of the State. If Rasmussen, under the circumstances existing, could drain his land, claim the water, and thereby acquire an additional water right and apply it on other land, especially if such land was so situated that the seepage and run-off could not return to the stream from which it was originally diverted, then every other person similarly situated can do the same thing. What then becomes of the vested rights of other appropriators from the same stream who for years have relied on the water of the stream and all its sources of supply including seepage and run-off from irrigation. I will go even farther than that. Admitting that such waters at some point could be returned to the stream, it does not necessarily follow that Rasmussen could claim the water. It all depends on the point at which the water is returned. Suppose, for instance, persons similarly situated to Rasmussen using water in Garfield county should conceive

the thought of draining their land and returning the water to the river with the view of recapturing it in Sevier, Juab or Millard county, and there divert it for beneficial purposes? What then becomes of the rights of other users in Garfield county who depend in part upon the seepage and run-off water being returned to the stream in Garfield county as was previously done?

The proposition contended for by Rasmussen is pregnant with serious consequences, and if accepted as the doctrine by which the rights of prior appropriators of water are to be determined hereafter in Utah it would go very far towards depopulating many of our prosperous farming communities. If the water sought to be appropriated by Rasmussen had had its origin on his land previous to its appropriation by others it would have fallen within the principle of the Willow Creek and other cases already considered. But, as we have shown, the water claimed by him had been previously appropriated and used by others and the excess thereof returned to the river from which it was again diverted and used. It is a fundamental principle of the law of irrigation that when water which has once been appropriated is again returned to the stream it becomes public juris and is again the subject of appropriation. When thus appropriated it may not be interfered with by others.

The distinction between the Rasmussen case and the Gribble case is not clearly marked or defined notwithstanding the opinion in the Gribble case is based squarely upon the Garns-Rollins case. The necessity of attempting a distinction is entirely dissipated by the fact that the Rasmussen case expressly modifies or overrules the Gribble case in all matters wherein they conflict.

Right to the use of water collected by drainage systems of which there will be more in the future than in the past where the rights of prior appropriators are involved must and will be determined by the principles enumerated in the Rasmussen case. If the rights of prior appropriators are not involved, then the Rasmussen case does not apply. In such case it may well be conceded that to the owners of the soil belong the percolating water.

SUMMARY

If the foregoing conclusions are correct the following propositions have been established:

(1) The common-law doctrine that to the owner of the land belongs the percolating water has been abrogated in the State of Utah whenever that doctrine conflicts with a right acquired by prior appropriation. (Sullivan and other cases).

(2) Rights to the use of water having its original source on private lands can not be acquired under the law of appropriation. (Willow Creek and other cases).

(3) He who seeks to develop water from his own land at or near the source of a stream which has been appropriated by others has the burden of proving that he does not thereby interfere with the prior appropriation. (Mountain Lake and other cases).

(4) In a farming community where seepage and run-off from irrigated lands in the vicinity find their way back into the stream from which they were originally appropriated and are again diverted from the stream and put to beneficial use such appropriations may not be intercepted and taken by the owner of the land through which they seep on their return to the stream. (Rasmussen case).

VICE-PRESIDENT HART: Ladies and Gentlemen: I shall be pleased to serve in this capacity. Last night your President gave you a scolding. He said that ten years ago he went up and down the State of Utah telling the farmers that there were one million acres of irrigated land in the State, and during the course of the day he heard the State Engineer say that at the present time there were one million acres of land irrigated in the State of Utah. Therefore, he says, you have not made any progress, and he scolded you because you had not made any progress. I got to thinking about that and I decided there had been some progress made in drainage. We have not been marking time all these years. One thing your president forgot about, when he said that no progress had been made was the fact that at least one third of that million acres of irrigated land had gone back to a condition worse than that in which the settlers found it as desert land. Through the process of irrigation, more than three hundred thousand acres of land have been reduced to a non-productive condition by water-logging and the accumulation of alkali.

The thing I am trying to get at is that there has been some progress made, and it is very fitting that the afternoon of this day should be set apart for those people who are making that progress. There are certain men who are taking up the slack in irrigation, and certain of the speakers will tell you later that about half of that area which has gone back to an unproductive condition is now organized into drainage districts for restoration to a fertile. producing condition, and steps are being taken rapidly for the organization of the other half. I call this the taking up of the slack, and, gentlemen, I am not so sure but what we are pursuing the wisest course in thus taking up the slack.

Let me ask, what particular advantage is it to take out high line canals at great cost per acre for irrigation water, and put in expensive storage works, if one of the chief results is to be the destruction of lands further down the slope, whose irrigation supply was taken out at low cost, and all that sort of thing, unless the slack is taken up? What particular advantage is it to the State to add another five hundred thousand acres of higher lands, expensively irrigated, and during the same period of time lose five hundred thousand acres of the former irrigated lands, which, by the way, are the cream of the respective valleys, and do nothing toward taking up that slack? And so, as I say, this

afternoon this congress is to deal largely with the subject of taking up the slack.

The great central thought of this congress, particularly Dr. Widtsoe's speech, has been the centralization idea, the taking in of numerous organizations into one organization. Practically all of the talks have been as to what can be done along those lines and what the benefits will be in case those things are done. In the drainage end of this field, those things have been done and those results have been obtained. Some of the men here today are going to tell you about it. As an example, Mr. Abbott, who is one of your members here, is secretary of the Millard County No. 3 Drainage District which comprises the same area covered by five irrigation companies, and the affairs of that great drainage district, composed of forty-four thousand acres, are handled by one board of three drainage supervisors, with one engineer and one attorney, in a very simple way. Everything is going along nicely, and the interests of the various units are well taken care of. It has occurred to me many times that the irrigation interests of that same area could just as well be handled by a small, compact organization, such as is handling the drainage interests, and if you want to talk about the consolidation of canals and so on, there are some seven hundred fifty miles of drains to be installed in that one district, which would make quite a comprehensive canal system, if you are thinking about it from the standpoint of irrigation. The congress has attempted to select speakers for this afternoon from the men who are actually doing these things, and not have some college professor or some government expert, as they call them, tell you about these matters. The first subject, as it should be, is that of the organization of drainage districts, and that subject has been assigned to a man who has had more to do with organization of drainage districts in Utah than any other one man. Formerly located in Millard County, he is now located in Utah County as County Agricultural Agent. While in Millard County he directed the organization of four drainage districts, which cover eighty-one thousand acres of land. Since going to Utah County he has taken up the work there and is organizing other districts. In my work I think I organize drainage districts; the land owners in a given district think they organize drainage districts, and the attorneys who are called in to follow out step by step what the law says to do, think they organize drainage districts; and sometimes the

engineers who are called into fix the boundaries and determine other factors, think that they organize drainage districts. But above and beyond all that, is the organization that we do not think about, and that is the awakening of the mental processes of the men who are to make up these bigger organizations into that frame of mind where they will cooperate and where that conservatism which was discussed yesterday is destroyed and where the various units and the various individuals are united together. That is what the county agents are doing in many of these counties. And they can do that better than anyone else, because when one of these county agents goes out to tell farmer Smith what is the matter with his cow, he can say, "My, you have a wet spot over there; you ought to drain it; and the only way you can do it is to join with your neighbors and form a drainage district." The next day he goes over to see farmer Brown about some other matter, and he will say, "You have land that ought to be drained." That does a little more good. Before long they all go down to a mass meeting and the county agent talks to them and gets them worked up into a fever heat. At the psychological moment he calls on a Government Specialist for aid, matters are fully explained to the landowners, and the organization is easily perfected.

I am very pleased this afternoon to introduce to you a gentlemen who has had more to do with irrigation and drainage districts than any other man,—Mr. Joseph P. Welch, now of Provo, Utah. (Applause).

ORGANIZATION OF DRAINAGE DISTRICTS

By MR. JOSEPH P. WELCH

(following Mr. Hart)

Mr. President and Fellow Farmers: The organization of drainage work in Utah today, as Mr. Hart has told you, is a big problem that is now confronting the Utah farmers. While down at Chicago recently, at a convention there, one of the boys of the Middle West said to me, "Well, Welch, I see that Utah is making quite a stir on Drainage." Two or three of the other boys laughed and said, "Why, we didn't think you had enough rainfall in Utah to water-low anything!" To those fellows drainage in an arid country, I suppose seems a sort of a joke. Perhaps, Mr. Chairman, that is why we have such difficulty in getting

Congress to listen to us some times. But it is, nevertheless, a problem. Mr. Hart has compared drainage and irrigation to you today and has shown you how the taking out of high line canals has water-logged the lower lands. Most of the drainage with which I have been connected is being installed in a great wide valley with about seventeen inches annual precipitation, what we commonly call a desert, just like the desert valleys that we call winter range for sheep.

In the spring of 1913 Dr. Widdtsoe called me in and he said to me, "Welch, we are going to put you down in a country which has a question mark on it." He said, "We regard it as one of the toughest propositions Utah has, but it is up to you fellows to go in there and figure out something for those men." Now, what Mr. Hart has said about what Welch has done is not all what Welch has done by a good deal. We have had other men from the College there—Dr. Widdtsoe has been there, we have had Engineer Hart; we have had all the help we could get, and the work is due to their combined efforts.

When considering the possible lines of development which will make Utah great, agriculturally, one soon discovers that there is one element which enters into every problem. That element, the limiting factor in our agriculture, is water. In the past irrigation has been the principal line of development; now the problem of drainage has come to the front and must be regarded as part of the big plan which will increase our cultivated acres.

There are now organized in Utah a number of drainage districts containing a total of about 135,000 acres. Only a part of this is installed, but large forces are at work with open dredges and trenching machines which are proving highly efficient.

There remains yet to be organized about 165,000 acres which will bring the total drainage area up to about 300,000 acres. This reclamation will increase our irrigated area about 35 percent. There will be developed by this drainage about one-half of one acre-foot of water per acre of which a good portion will be lost due to the lands being low, unless pumping for irrigation be more extensively employed. The water developed and capable of being used from six acres will probably irrigate one acre on an average. This means a wonderful development in itself, since this drainage will provide irrigation water for about 50,000 acres.

The reclamation of the entire drainage area will provide homes for 10,000 families, if we allow thirty acres as an average sized farm per family. This means much to Utah. Why let our boys build up Idaho, Colorado, Wyoming, Arizona or Canada, when this land lies right in the heart of the best developed sections of the West?

This is not poor land. In fact it is the choicest land we have when once properly built up. The soil is of fine texture, of great depth and contains an abundance of the mineral plant foods.

Some of these soils are alkaline and require washing after drainage. One district in particular was very bad; common table salt being the most abundant alkali present. When the washing of this land began, after drainage was installed in 1915, the drain water carried a solution of 4.8 percent soluble salts, showing that an enormous quantity of alkali was leaving the soil. In 1917 the solution had reduced to 3.1 percent, and in 1919 it tested only 1.7 percent soluble salts. It is estimated that there was carried from this drainage district of 5,000 acres in the first year's drainage water, over 20,000 minimum carloads of salt. When this was done the land began to be profitably productive

and soon will be giving off water which will not be too salty to be used for irrigation.

The real problem that seems to be in the way of development is that of getting the people who own these lands to work together, and there is where the county agent functions. The county agent should be a man of vision. He should study his county and see its possibilities and he should aid the people in putting the work over. His work is leadership. Frequently the farmers are anxious to do something, but don't know just how to go ahead. Always there are many who are satisfied and who do not care to improve.

When it comes to organizing drainage districts one sometimes runs up against a number of snags. My first efforts at organizing a district were very discouraging for a while. Public meetings were attempted. There was so much criticism, so much argument, that we really could not get anywhere. Then we attempted another method of arousing public sentiment, by going from farm to farm, getting the farmer to go out with us on his place, boring down and showing him the water, explaining the water movement and also explaining how the alkali came to the surface.

After weeks of that sort of work we practically covered the territory and we succeeded in moulding public opinion favorably toward the work. Before you can proceed with the organization of a drainage district it is absolutely necessary to get sufficient public sentiment. It may take years to mould public opinion, but when the people are once properly convinced, they begin to get along pretty well.

Methods of converting the people to drainage might be mentioned. Public meetings, of course, are thought of first. Generally, there is a public meeting held, "a general revival", you might say, with speakers brought in from the outside. Usually I have tried to get the assistance of the best help possible and have been fortunate in securing cooperation from the government drainage engineer, Mr. Hart, who understands this proposition a great deal better than I do and who is able to answer questions and give information, which invariably helps to create public confidence.

In the beginning I have found drainage excursions better than public meetings. If there is a place accessible where you can take your farmers so that they can see drainage in operation, or even see the machinery constructing the work, it has a very good effect on their minds. A farmer likes to go and see the drains in operation in another territory; he likes to see the machinery at work; he likes to know how these things are done. Invariably a little drainage excursion into a territory where some land is being successfully drained proves to be of considerable help, even though you may get only a dozen or two dozen men to go along. They go back home and tell the others about it. I have found it to be one of the very best ways of convincing people.

The public press also serves admirably in this direction. Sometimes we begin three or four years before we expect to get to work in a district with articles in the newspaper, so that finally when we are ready to begin the work, so effective has been the moulding of public opinion in favor of the project that nobody really knows where it originated.

There are a number of difficulties frequently encountered. For instance, you will always find when you first undertake a proposition of drainage, a good deal of opposition due to misunderstandings. There are frequently fair minded men who are wanting to do the right thing but who are not sufficiently informed, having had no previous exper-

ience along that line. In many cases they are men of influence in the community. One of the first steps should be to get in proper touch with these men and help them to understand the problem, for they make good support later. Sometimes we find the opposition of influential men is due to personal interests. It is really not very uncommon to find a pretty big man in his community who does not want a drainage district proposition to go through. Perhaps he has a salt grass pasture which he feels is going to be ruined if the drainage ditch lies under it, and so he proceeds to oppose the proposition from his personal point of view because he may not feel the necessity of developing that particular land which he apparently will be compelled to develop. I remember a case at one time where a man owned several hundred acres in a district and he opposed the drainage district proposition with all his might because it would drain his land and kill the salt grass. Since that time I have understood that he sold that place for about three times what he could have obtained for it before the drainage. He paid only, I think, the first annual payment of interest on the drainage. His land increased in value about three hundred percent, and yet there had been no improvements made whatever except the boundaries of the district were laid out and construction was beginning. Somebody saw that it was going to be valuable and bought him out. We have had instances where companies loaning money on real estate when a district was thoroughly organized, and even before construction work had begun, have loaned as high as fifty percent of the value of the land, because it was in a drainage district and drainage was coming to it.

One of the greatest difficulties we have had, after we have made up our minds to get started, is that of farmers wanting to tell the engineers how the work should be done. It is the hardest thing in the world sometimes to get them to leave the matter in the hands of the engineer to make the preliminary surveys, and to develop the plans and specifications. They frequently say, "We want you to run a big main here and we want you to run a lateral there and another one there." They have their opinions about it and sometimes it causes considerable delay. I remember one particular incident where a man came to me condemning the engineers pretty strongly. He was a farmer and he was also a carpenter. I said to him, "Why does a man come to you to build a house for him? Why does he not build it himself?" He replied, "He comes to me because I know more about the building than he does." I said to him, "Then he employs you to put up his house because you know the business and he does not?" He said, "Just exactly." I then asked him, "What did you employ this engineer for?" He answered, "It is all right; we will do what he says." That was all that was necessary.

Boundaries of districts sometimes cause considerable discussion. It is natural to think in the terms of surface markings. Some fellow will want the drainage district to run up to the state road; another will say, "Let it go to the railroad track." Another will say, "Right here is the township line; let those fellows over there in that community do their own work and we will do ours." Another man will say, "Right here is a certain irrigation company; let us stick in our own territory and let those fellows over in that irrigation company stick to theirs."

In one district of forty-four thousand acres—No. 3 District in Millard County—there are parts of four different irrigation companies, three different irrigation companies taken in quite completely and part of the fourth.

What does really determine the boundary of a drainage district?

The size of the district is a very important factor. The factor determining the real boundary lies beneath the surface and is determined by the area needing drainage. The larger the district the less will be the cost per acre, generally speaking, since one board of supervisors, one engineering firm, one contractor, and one attorney will work the entire area. Then, too, the cost of advertising and many other costs are the same for a small district as for a large one. Large districts will attract large bonding houses and insure lower interest rates and more competition in bidding. Also, they will attract better price on tile. Some men do not like a large district. Personally, I favor a large district, and for the reasons I have just given. It costs a bonding company almost as much to investigate a bond issue on a little district as it does on a large one, and as a rule a large issue is more attractive.

I want to touch now upon the principal steps necessary in process of organization. I spoke a few moments ago about creating public sentiment. That is the first step and one very necessary step in the organization of a district. After creating the proper sentiment, so that you feel sure that you can get a district through, a petition is prepared and circulated through the district, petitioning the county commissioners to create the district. This petition is for the purpose of determining public sentiment in a tangible way so that you can carry to your county commissioners the proof that there are sufficient people interested in a drainage district to put the proposition over.

This petition is generally circulated by enthusiastic farmers of the district who are capable of going out and convincing men of the feasibility of the work. Sometimes in a public meeting somebody will get up and nominate a man without stopping to think of his attitude toward the work. We have had it happen where we have had a man on the committee to circulate such a petition who was positively opposed to the proposition. Invariably that man would come back with his petition saying, "Nobody wants to sign; nobody wants drainage." We have had cases where we have realized that man and sent out a man who was favorably inclined and he would bring in seventy-five percent of the people as signers. So it is important to get men on the work who are favorable to it.

In the petition approximate boundaries are specified and a rough estimate made of the general outlay of the system. The land included within the district is specified and the men who sign their names record the number of acres they have under their control. If one-half of the people owning one-third of the land, or one-third of the people owning one-half of the land, sign in favor of the creation of the district, the district may be created. The law is made broad in this regard in order that no one or two men may retard the development.

There is always some man who does not want to let you do him good; there is always some fellow who feels that he can solve his own problem; there is always some fellow who has some personal reasons for being against such an organization. It is never advisable to hold out until you can convert every man, because that is generally an impossibility. It is important to secure the proper number of signatures. It is also important to secure as many as possible. I would not attempt to start with just a bare amount sufficient to get over with the proposition. The larger the percentage of the people that sign in favor of the district, the more favorable will that district look to men who are considering the purchase of those bonds, because one of the first things a bond buyer wants to know is, what is the moral risk on the people who are living in the proposed drainage district? They will ask, "What

is the moral risk? Will these men get up and leave or will they stay there and develop the land?" If a high percentage of people sign up, it looks very much better.

Having secured the proper number of signers, the petition is presented to the county commissioners at one of their meetings and, if they favor the proposition, a date is set for the hearing of protests. This date should be advertised in the papers for not less than twenty-one days. If the commissioners consider the proposition a feasible one, a board of temporary supervisors is appointed to handle the proposition, and these supervisors are empowered to go ahead with the work, employ the necessary legal advice and the necessary engineering help. Cost estimates are made and plans and specifications developed which go to show to the commissioners, when these data are assembled, whether this district is practical or whether it is not.

Provision is made by law for the financing of the preliminary work on the following plan: should the project prove impractical, the signers of the petition pay the costs by assessment, which must not exceed one dollar and fifty cents an acre on the land within the district. Preliminary costs rarely run that high; usually they are very low, but they may go as high as \$1.50 an acre; the signers of the petition being responsible therefor.

On the day set for the hearing of protests, a man who is unfavorable to the creation of the district may go before the board of county commissioners and explain his reasons. If it be possible to drain the project without giving this man any benefits, he may be left out. If he be in a district where the rest of the farmers cannot be drained without giving him the benefits of drainage too, he will be told that the drainage district must go ahead and that he must bear his proportion of the burden.

At this final hearing the cost and other estimates and also the protests are presented. At this time men may come in who have perhaps been just on the border line. They may not have wanted to be in the district before and have been left out by common consent. If they have been converted to the district they may be admitted at this time, and the permanent boundaries are fixed.

Then the question of financing the entire district comes up. A bond election is generally called in order to get the sentiment of the people as to how they want to raise funds. This election is advertised for a specified length of time, to be held at a specified place. At this election each farmer concerned votes "Bonds, Yes," or "Bonds, No." By this means the method of financing the district is determined. Bonds are usually voted on account of the easy payments and the low rate of interest. These bonds go on the market at not to exceed six percent. Pretty nearly every farmer can use six percent money today. He sees an opportunity of securing six percent money for this improvement, and he does not need, if they so make the contract, to pay anything but the interest for the first ten years and from then on, the interest and a specified amount of the principal until the indebtedness is wiped out. This is a very good means of securing cheap money, and the average farmer, even though he might be able to pay the entire amount, sees a chance of using his available money to bring in a bigger return than six per cent. He usually is big enough to look to the welfare of his fellow men who does not have the money available; and for the good of the entire district, he votes in favor of the bond issue.

The bonds being voted, they are advertised for sale and sold. If it is a large issue, as I have mentioned before, it will interest more bond

buyers. The supervisors should also advertise for construction contracts. These advertisements should run a specified time and efforts should be made to interest the most efficient and responsible contractor. After all this is done, the construction work proceeds.

The creation of a drainage district under the Utah Drainage Law gives you a plan that is so easy and simple that it should not cause failure to any industrious farmer.

In the selling of bonds and the letting of contracts a good deal of outside help has been secured. Most of our Utah districts have profited greatly by government cooperation, given through the office of Mr. Hart. He has given substantial aid in organization and in advice on construction. He has also given great service in aiding in securing market for drainage bonds. His acquaintance with many bond buying houses has caused a keen competition in bond sales, thus saving many dollars for these districts.

Four districts, recently selling bonds at the same time, disposed of them as follows: Two of them, cooperating with the government, sold at 97.75 percent par and 98 percent par respectively; the other two not cooperating with the government, sold their bonds at 90 percent and 92 percent par respectively. The saving on the two cooperating districts was about \$20,000.

I believe this was largely due to the wider publicity given to these two cooperating districts. I believe another thing that entered into the proposition was that those bonding houses had greater confidence in the work when government cooperation was established. As a county agent, it has always been my policy to secure aid and information from all sources possible, from the Agricultural College, from the Government office, and from other sources.

The work of drainage is very important in this State today. Almost every county has some territory that needs drainage. When you go back home to your people I suggest that you keep in mind, first, that there are yet to be organized and drained in this State about 165,000 acres; that part of it very likely lies in your territory; that your favorable opinion and the favorable comment you may make will help in this work, and that it is possible for us to increase the irrigated area of Utah by one-third if we will all get together. Do not make the mistake that one district is making right now of wiring the Senator for funds, when the government is in debt billions of dollars, when by such a simple method as we have in Utah for financing drainage districts, we can help ourselves. Sometimes a district, not having any drainage, will wait months and months hoping for outside aid, when all they need to do is just get together and the plan can be perfectly worked out for the financing of their own business and they can do it without help. I thank you. (Applause).

MR. HART: We have enjoyed the talk by Mr. Welch, and it has been very instructive. Lest you think all of the problems of drainage are solved by the mere organization of districts, we have thought it wise to inquire further along this line. Mr. Adams in his talk yesterday on Irrigation Districts in California, said that one of the things the bond houses were afraid of in the operation of the irrigation district was internal management,

that is, the management or control of affairs by landowners themselves. Mr. Welch has said that at the hearing and the organization of a drainage district, three drainage supervisors are appointed by the county commissioners to handle the affairs of the district. The law says three competent persons shall be so appointed. It does not specify where they shall live nor who they shall be. In every case, these three competent persons have been land owners within the district. Critics have said at first that drainage organizations would not do well because of their being in the hands of farmers who did not know very much, and that that sort of thing ought to be put in the hands of men of business training. I want to say that in my experience with some fifty drainage districts here in the West, I have come to the conclusion that the management of drainage affairs is in exactly the right hands in being in the hands of the leading people of the community—the landowners who are directly interested and who are willing to spend their time for the mere pittance which is allowed to drainage supervisors.

Mr. Welch also suggested that the drainage law outlines by steps the various proceedings of organization. It does not say much about the administration of the affairs of drainage districts and, therefore, there are some very knotty problems which arise. It has commanded the best work of some big men to handle those matters. I happen to be in a position to know why, and could tell you how some of those problems have been met by some of those men, but I know you would rather hear from a man who has been through the mill, a man who has solved some of those problems in his own district, and who has seen those problems solved in adjacent districts, and has, perhaps, seen problems not solved in adjacent districts.

I take great pleasure in introducing to you this afternoon, Mr. Oscar A. Anderson, of Delta, who is president of the Millard County No. 4 District, a ten-thousand-acre drainage proposition. (Applause).

ADMINISTRATION OF DRAINAGE DISTRICTS

By OSCAR A. ANDERSON

of Delta, Utah

The administration of Drainage Districts requires time, personal supervision, energy, executive ability, practical judgment, and a deep interest in the work; as well as financial experience. Any person who accepts the office of a supervisor must be prepared to spend a considerable part of his time, without hope of adequate financial reward, in the performance of his official duties; in looking after, not only the business affairs of the district, but in supervision and inspection of actual construction and maintenance work.

The word "Supervisor," implies "Supervision;" and supervision requires not only time, but personal effort; and many times personal inconvenience and personal sacrifice. It requires the energy of matured manhood, a perseverance that knows no failure, that can meet and successfully overcome, apparently insurmountable obstacles. Supervision requires executive ability of the highest type, the power of successful organization and the ability to direct the work and efforts of men; it requires practical judgment based on practical experience, a keen foresight, with the ability to comprehend and solve practical and oftentimes difficult problems. To be qualified for the office of supervisor, a person must have had some experience in financial matters, because he is called upon to collect and expend in many instances hundreds of thousands of dollars, so he must know the value of money and how and when to spend it. He must not go into extravagance, neither must he be parsimonious, he must demand good work and be willing to pay what it is worth; a supervisor must acquaint himself with every business detail and must know and understand the physical problems of the district and of the construction work.

Supervisors must keep accurate accounts, in suitable books prepared for that purpose, and render when and as required by law, complete and detailed information wherever available, and keep in close touch with the sentiment of the land owners of the district on all important problems, either by personal contact or by public meetings called for the purpose of discussing the problems of the district, or by both. They must realize that the responsibility for the success or the failure of the district depends upon them, that responsibility can not be shifted to the engineers, the contractor, or to any one else.

After a district has been organized, the next preceeding is to finance the construction work; this is usually done by issuing and selling bonds, and for that purpose, competent legal help must be employed. However, the supervisors must see to it that the bonds are sold for the best price obtainable on the market; this can be done by calling the attention of prospective bond buyers to the merits of the district; that is, to the feasibility of drainage, the productivity of the soil after drainage, the stability and character of the settlers and improvements on the lands within the district, and to other pertinent facts. A sufficient amount of bonds should be voted in the first instance to insure ample funds to properly finance the construction, because it is often very difficult to float a second issue of bonds; it is advisable to reserve from sale, in the first instance, and hold for sale at a later date a small fractional part of the issue, and if it is not necessary to sell them, they can be destroyed; other-

wise they can be offered for sale when additional money is needed; interest coupons can be detached from bonds not sold up to the date of sale, and in this way thousands of dollars in interest can often be saved, and frequently bonds will sell for a higher price on the market after the construction work is well under way and the success of the district is assured.

After the district has been financed, it should be designed by a competent drainage engineer, and plans and specifications prepared; this work should be done very thoroughly and accurately and the supervisors should give the engineers the benefit of their practical knowledge, experience and judgment. Their suggestions on the fundamentals of the design are often valuable. Usually they know the best location for the main out-let or out-lets, the best methods of disposing of surface waste water, the natural drainage of the district, the direction of the movement of percolating and seepage waters, the porosity of the soil, the rise and fall of the water table, the canal losses from seepage and other facts of a practical nature, which are of inestimable value to the designing engineer. Of course, purely technical engineering questions must of necessity be left to the engineer; the supervisors, as a precautionary measure, should submit the design, plans and specifications to two or more engineers, on the theory that there is "safety in a multiplicity of counsel," the design must be as nearly perfect as possible to insure perfect drainage, and economy of construction; the depth and distance between the drains, and the proper sizes of tile to install are questions of vital concern to the successful drainage of the lands, and many factors must be considered. The supervisors should study these problems seriously with the engineer.

The awarding of the contract is the next order of business, and the supervisors should not be content simply to give notice that contracts are to be let in the manner provided by law; they should make a personal effort to obtain spirited competition at the bidding. This can be done by personal letters addressed to prospective bidders, by additional advertising in engineering and construction journals, and often by personal visits. The advertising matter should refer to the merits of the district from a contractors point of view, such as the absence of irrigation, low water table, absence of quick-sand and rock, if such be the facts, and other features likely to attract the attention of the contractors. It is always advisable to take the contractors over the district, and with them, make soil borings to locate the water table, and test the soil so that they may have a thorough knowledge of the actual condition they will encounter, as far as possible. If the tile is to be placed within six feet or less of the surface, this fact should be emphasized, as shallow construction is very much less expensive than deep construction. In awarding the contract you should take into consideration not only the lowest bid, but the responsibility of the bidder, such as his experience, integrity, reputation, financial backing, equipment, etc.

CONSTRUCTION

During the progress of the construction work, the supervisors must be constantly "on the job," so to speak. An action for damages on a contractors bond for defective work is a very poor substitute and very inadequate remedy for a defective drainage system; no damages that could possibly be recovered could compensate for lack of drainage due to laying of defective or broken tile, uneven grades, poor alignment, sagging of the tile line, improper or lack of protection to the joints where such is

needed, insufficient capacity of the outlet, and many other difficulties which may arise from negligence or carelessness on the part of the contractor or some employee of the contractor. In my judgment, there should be a rigid inspection of the work done during construction, either by the supervisors themselves or some competent person whom they may employ, and the written contract with the contractor should specifically provide that approval of the work by the inspector shall not be construed as an acceptance of the work by the supervisors, and that inspection shall not relieve the contractor from the performance of all the obligations and conditions, or any of them, specified in the contract. I don't mean that the supervisors are to assume the duties of the engineers. Neither is the instruction by the Supervisors or their agent to relieve the engineers of any of their duties or responsibilities. Instruction should rather serve as an additional precaution against defective work. Many times the engineers are not present when the tile is being laid, but the instructor must see each joint of tile placed in the ground and observe the manner in which the same is laid; there is well defined line of demarkation between the duties of the engineer and the instructor, one can assist the other. It is like having two pilots on a ship; what might escape the attention of one will probably be observed by the other.

The salary of an instructor is infinitesimal in comparison with the cost of digging up and replacing even a very small fractional part of tile line; of course and the engineers must see to it that the construction is technically in accordance with the plans and specifications, but the supervisors must bear in mind at all times that they are the officers to accept and approve, or to refuse to accept the work when done; and in the last analysis, the responsibility is theirs and not that of the engineer. The supervisors can not go before the public and place the responsibility for a defective drainage system on either the contractor or the engineer. If the drainage does not work, they must stand the public censor which they will so richly deserve. Before accepting the drainage system from the contractors, the supervisors must know to a certainty by a practical demonstration that it is efficient and is adequate to drain the lands. If the work is done by the contractor in accordance with the plans and specifications and the drainage system is defective, a difference of opinion may arise as to whether the contractor can be held responsible or not. This will probably depend upon the stipulation of the contract, but that is a legal question and beyond the subject matter of this paper.

MAINTENANCE

The completion of the construction work, and its acceptance by the supervisors does not by any means end their duties or responsibilities. Drainage systems must be maintained, tile lines must be protected, outlets must be kept clean; occasionally a joint or two of tile line must be replaced, the tile line must often be cleaned by washing or sluicing. It frequently happens that tile laid in soft dirt will sag or get out of alignment due to pressure above, and if it does sediment is sure to settle at the low points.

Provisions must be made to meet these situations when they arise and to remedy them with as little delay as possible. It is usually advisable to employ an engineer to direct and supervise the maintenance but if the district is small, it may not require all of his time. However, he should be available when needed. New construction work in an irrigated area must be carefully guarded during the period that irrigation is being carried on. This is especially so before the dirt is

well packed around the tile; often a careless irrigator will permit his waste water to flow into a tile line, covering it with loose dirt; and the waste water finds its way into the tile, often carrying with it quick sand and mud which may settle in the tile line for a distance of a quarter of a mile, and partly if not completely obstruct drainage. Waste water should never be permitted to flow into a tile line; the damage that might be done to a drainage system by a settlement of water not controlled during a period of even one night might cost the district thousands of dollars to repair. It often is necessary to install a complete system of service ditches to take care of the waste water from the farms. If it is necessary to carry irrigation water over a drain, this should be done by a flume or a well-puddled clay-bottom ditch, or other suitable construction, which the engineer may recommend. The irrigation water, if permitted to find its way into a drain, is just as disastrous as waste water. A difference of opinion prevails as to whether the supervisor should, at the expense of the district, protect the drains or should require the farmers themselves to protect them. It is my opinion that the district must undertake this work and design a plan for the entire district that will properly protect the drain; if this is left to the farmers, each may adopt a different plan for protecting the drains on his own land and many will do absolutely nothing. If the protection is undertaken by the District, the work done on each particular farm will be a part of a completed plan, but if left to the individual farmers, chaos will result. A careless farmer who fails properly to protect the drain, or who through neglect permits either waste water or drainage waters to get into it, may damage not only himself but his neighbor along the tile line and it is often hard to fix the responsibility if the damage is due to the contributing acts of two or more farmers. Some parties suggest a dike on each side of the tile line as a means of preventing either waste water or irrigation water from getting into the drain, and if the dikes are properly constructed and maintained this probably is as cheap a method as any to protect the tile line, and in my judgment, this work should be undertaken by the supervisors.

It is sometimes necessary to prevent irrigation at night in newly constructed drainage districts. However, if irrigation is permitted at night, the supervisors must see to it that the farmers do not go to bed and leave the water running. Supervisors should adopt suitable by-laws to regulate and control the use and disposal of irrigation and drainage water, and should enforce obedience to their by-laws by court proceedings if necessary.

MR. HART: Mr. Anderson's paper has been very instructive; particularly as it comes from a man who has met these problems and has solved them.

A drainage district, being a quasi-public corporation, is of a somewhat different nature than a regular corporation; and having to do with public affairs its various steps have been outlined very carefully in the law,—the steps of organization, and so on, and the duties of the county commissioners, the county clerk, and the supervisors when they are appointed. That introduces

some problems that probably do not occur to the landowners themselves, because, if the law specifies exactly what shall be done day by day, unless you do that, you are in difficulty. So it becomes the problem of the attorney of the district to see that every step is taken, that the minutes record those steps, and that the county records show the steps in which the county is concerned. When a transcript is taken of this record, it must be accurate in every detail, because, when the bonds are finally sold, the successful bidder always has the right to ask that a transcript of the record of all proceedings go to some big bond attorney in the East, whose business it is to examine the transcript and report to the bonding houses whether the proceedings have been properly followed. So there are those two things with which the attorneys have to do; first, the separation of the record; and second, its analysis, generally, by some attorney for a bond house in the East. If a comma is left out, if a date is wrong, if a "t" is not crossed, if the advertisement for twenty-one days in the newspaper runs only twenty days, if the county clerk forgets to post a notice up in front of the court house, or somebody forgets to submit an affidavit, or the publisher forgets to put in a certificate of publication, the whole thing will fall by the wayside.

We are very fortunate in having with us this afternoon an attorney who has prepared the transcript for two districts—at least in a consulting capacity with other attorneys—and who did so well that he has recently been selected by a firm of eastern attorneys to represent them in this part of the country in the examination of transcripts. I take great pleasure in introducing to you this afternoon Mr. A. M. Cheney, of the law firm of Cheney, Jensen and Holman, of Salt Lake City. (Applause).

THE DRAINAGE DISTRICT LAW

By ATTORNEY A. M. CHENEY

Mr. President and Gentlemen of the Congress:—I agree with Mr. Hart in his statement that there has been during the last few years quite a wonderful development of our agricultural resources thru the more economical use of water in irrigation and thru the application of drainage. While this development, particularly with respect to drainage, has been almost wholly confined to the last six or eight years, the first drainage district law was actually placed on the statute books some twenty-four years ago.

The first enactment in 1896 was, to be sure, a mere skeleton or outline. I am not advised as to what, if any, attempts were made at that time to operate under it. The law was revised and incorporated into the Code of 1898. This first draft of the law, fragmentary as it was as to procedural details, contained the necessary restrictive provisions giving to the land owner the voice and right guaranteed him by the Constitution. Necessarily, however, the practical application of the provisions of the law indicated and pointed out omissions and defects, and the law as first enacted was amended in 1905 and again in 1907. Strangely enough, in making these amendments, our Legislators were not content with making the law better—they made it worse by cutting from it the very provisions without which it was rendered vulnerable to attack as being unconstitutional, as in the case of Argyle vs. Johnson. This case, which came before our Supreme Court in September, 1911, was the first litigation arising over the law, and in it we have the first authoritative construction of its provisions by our Supreme Court. The Act was attacked on two principal grounds:

- 1st—That it authorized the drainage of lands for private gain, and
- 2nd—That it permitted the taking of private property without due process of law.

In discussing the first proposition, Mr. Chief Justice Frick, in the course of the opinion, said:

“Some authorities are cited which hold that under certain conditions it is necessary that the public health be subserved by a proposed system of drainage, in order to authorize the imposition of a tax to pay for the construction and maintenance thereof. We remark, however, that the act in question is not based upon the theory that any drainage authorized by it shall promote the public health. The theory upon which drainage laws like the one under consideration are based is well stated by Mr. Justice Gray in *Head vs. Amoskeag Mfg. Co.* 113 U. S., 22, 5 Sup. Ct. 446, 28 L. Ed. 889, where, in speaking of such statutes he says: ‘The statutes which have long existed in many states, authorizing the majority of the owners in severalty of adjacent meadow or swamp lands to have commissioners appointed to drain and improve the whole tract, by cutting ditches or otherwise, and to assess and levy the amount of the expense upon all the proprietors in proportion to the benefits received, have been often upheld, independently of any effect upon the public health, as reasonable regulations for the general advantage of those who are treated for this purpose as owners of a common property.’

In 10 A. & E. Ency. L. (2nd Ed) 226, in discussing the principles upon which drainage statutes are upheld by the courts, it is said: 'And Statutes, such as have been enacted in several states, authorizing a designated proportion or number of the owners of adjacent swamp or overflowed land to institute proceedings whereby the whole tract may be drained and the expense thereof assessed upon all the proprietors in proportion to the benefits received, have been upheld, independently of any effect upon the public health, as reasonable regulations for the general advantage of persons having a common interest in the proposed improvement.'"

Further quoting from *Argyle vs. Johnson*:

"The weight of authority is clearly to the effect that laws like those in question are not vulnerable upon the sole ground that the proposed drainage may not be conducive to the public health. That there is an element of public use or benefit under such laws sufficient to authorize the principle of eminent domain to be invoked in making them effective, the authorities already referred to leave no room for doubt. The objection last referred to must therefore be overruled."

Upon the second proposition the Court held that the law was unconstitutional because no proper opportunity was afforded the land owners to be heard before a competent board or tribunal upon the question as to whether their property should be held liable for any amount of the proposed assessment for constructing the drainage system, before the tax lien was established against their property.

The Court concluding states:

"As we have already pointed out, however, the statute in question is not objectionable for the reason that drainage is permitted without showing that the same is necessary to improve or benefit the public health. Drainage statutes like the one before us, like irrigation statutes, are based upon the theory that lands, otherwise useless, may be reclaimed and devoted to a useful purpose. In this reclaiming waste lands, the owners are directly, and the public or the state is indirectly benefited. *Hoagland vs. Wurtz*, 41 N. J. Law, 175. By such laws it is not intended, nor do we hold, that they may be used for the purpose of merely making lands already used for one agricultural purpose available for another and different agricultural purpose; but, as already stated, the statute may be invoked only for the purpose of reclaiming waste, overflowed, or swamp lands. Public health is no more an element in such a statute, than it is in a statute authorizing the formation of irrigation districts by a certain number of arid landowners to reclaim such lands. The purpose of both statutes is the same, namely, to reclaim waste lands, and in that way benefit both the owners and the public. Such laws are salutary, and should be reasonably construed, and, unless violative of some fundamental or constitutional right, should be upheld. In adopting such laws, however, the rights of all interested persons must be recognized and protected, and an opportunity to be heard must be given. In this respect, the statute in its present form is defective and hence must fall."

For the purpose of correcting the defects suggested in the decision in the *Argyle* case, the statute was again amended in 1913, and the

Supreme Court in the Corinne case, speaking of the effect of these amendments, said:

"The foregoing sections of the act, and the other provisions thereof to which we have referred, clearly obviate and overcome the defects in the law as passed in 1907, and pointed out in the Argyle opinion."

A further amendment became necessary in 1915 to render effective the requirements as to notice of elections, pointed out in the decision in the Moody case, and at the same time two or three other sections of the act were amended as to certain matters of procedure and the disposition of tax moneys, etc. The necessity, however, for a somewhat radical revision as to procedural detail was by this time fully apparent, and again in 1919 the law was amended at some length for the purpose of clearing up many details of procedure which had theretofore been left entirely to conjecture. This amendment makes clear the necessity and function of the Primary Benefit Assessment Roll as distinguished from the annual estimate and tax levy, introduces the procedure for validation of organization and bonds somewhat as contained in the Irrigation District Law, and on the whole clears up many doubtful questions, particularly as to procedure. The law as it now stands, after a metamorphosis of a quarter of a century, is, I have no doubt, still somewhat crude in some respects, but it has nevertheless proven to be a practicable, workable law. Under it perhaps a dozen districts have been organized and are operating.

It may be interesting at this point to stop and observe or consider the characteristics of a drainage district—What is it? It isn't a town, city, school district or a county, but it is in the same sense a distinct political sub-division or arm of the State. As was said by the Supreme Court of California in *Re Bonds of Madera Irrigation District*:

"Whenever a special district of the state requires special legislation therefor, it is competent for the legislature by general law to authorize the organization of such district into a public corporation, with such powers of government as it may choose to confer upon it. It is not necessary that such public corporation should be vested with all governmental powers, but the legislature may clothe it with such as in its judgment are proper to be exercised within and for the benefit of such district. Being created for the purpose of discharging only one public purpose, it is not requisite that it have power not necessary therefor, or which would be appropriate to a corporation organized for some other purpose. Neither is it requisite that such corporation should have legislative or judicial powers conferred upon it. It may be organized for the mere purpose of exercising executive and administrative functions, with the added power of making such prudential rules and regulations as may be necessary for the exercise of the particular functions intrusted to its charge. The powers committed to a public corporation organized for the administration of a public park or for the government of a levee district, or for the control of the police department, need be only such as are peculiarly appropriate to such organizations."

A drainage district is then, a public corporate body politic invested with those particular powers conferred upon it by the state for the

purpose of carrying out a particular development of the state's resources, and the state has invested it with taxing power, the right of eminent domain, and certain other regulatory powers.

Matters of organization, and management and control of drainage districts have already been discussed somewhat at length, and to enter upon a further statement or discussion of such matters would of necessity be tedious and tiresome, and besides, many of you as officers of drainage districts, are perhaps off-hand more familiar with those details than I am.

I do, however, want to say a few words about the assessment, the tax and the bonds. These particular matters are, after all, at least of more pecuniary interest to district officers,— and certainly of more direct interest to district land owners—than are the mere details of district organization or management, or than any extended or academic discussion of other phases of the law.

One of the first duties of the Board of Supervisors, after the feasibility of the district has been determined and its organization confirmed, is the duty of viewing each several parcel of land comprising the district and assessing the benefit and the damage; that is, determining in dollars and cents the per-acre benefit or damage of each parcel as compared with every other parcel in the district, and compiling what is called the Benefit Assessment Roll. Now, just what is this assessment of benefit? It is not the tax; it is not the amount of money to be paid by way of tax, except perhaps that it measures the limit of payment. It is merely a valuation in future placed upon the land—an estimate of the value of the improvement to be added to the land. It is a valuation in the same sense that the assessor's valuation of property for the purposes of the general property tax is a valuation; and it serves the same purpose exactly. The benefit assessment roll, after being equalized, (provision for which is properly made in the law) is filed and becomes the permanent valuation base upon which the rate of levy of the tax is computed. It is not the assessment of tax; it is not the levy and it is in no sense a lien upon the land—it is merely the valuation basis for the tax.

The annual estimate is a computation and statement of the amount of money which the district will need for the current year including the amount necessary for maintenance, overhead, interest, sinking fund, and all other purposes. The ratio of this annual amount to the aggregate of the valuation roll gives the rate of levy for the year, and by the simple process of extending the levy against the respective parcels of land, the tax of each land owner is fixed. This tax constitutes a direct lien on the land and improvements.

Sec. 2058 of the law provides:

"All drainage taxes levied and assessed under the provisions of this title shall attach to and become a lien on the real property assessed from and after the second Monday in March. Drainage taxes shall become due and delinquent at the same time and shall be collected by the same officers and in the same manner as state and county taxes, and when collected shall be paid to the treasurer of the board of supervisors."

Drainage district taxes, like irrigation district taxes, have, by most courts, including our own, been classified as special taxes or special assessments. Perhaps they are, and perhaps they are not. They may be distinguished from special assessments, strictly so-called, in that only the amount of the yearly levy of tax becomes a direct lien on the lands,

while in case of true special assessments the entire cost of the local improvement is at once levied as a tax and immediately becomes a direct lien even though the amount may be, and most often is, payable in installments. These taxes are special taxes in the sense that they defray the cost of local improvement. In the method of levy, and accrual of lien, however, they partake of the nature of general taxes. They are, in fact, a sort of hybrid, fathered by the special assessment and mothered by the general tax. Judge Thompson, the eminent bond attorney of New York, in speaking of the irrigation district tax under our irrigation district law (and the tax under the drainage law is in all respects similar) is reported as saying that:

"This tax seems to be a general tax payable out of a special fund."

The cost of any improvement by way of drainage is, of course ultimately paid by taxes. In almost every case, however, the construction cost is first met from the proceeds of the sale of bonds of the district.

After the organization of a district, and before any work is undertaken, or contract let, or tax levied, the land owners may, at an election specially called for that purpose, vote for the issuance and sale of the bonds of the district in a sufficient amount to furnish money to cover the cost of construction of the drainage system.

These bonds are promises to pay money in much the same sense as an ordinary promissory note. The district's bond is a promise to pay money. It is backed up by its covenant to levy annually a tax sufficient to pay off the bonds when due. Whether an issue of such bonds constitutes anything more than that—a solemn promise to pay money and a covenant that the district will exercise its taxing power to have on hand the moneys with which to pay—I personally very much doubt, and in saying that, I am not unmindful of the fact that Section 2072 of the law says:

"Whenever any such drainage district bonds shall be issued in accordance with the provisions of this title, such bonds shall constitute a lien upon all of the lands and improvements thereon within the boundaries of the district, and the board of supervisors of said district shall, from time to time, as hereinafter provided, levy a sufficient tax to pay the annual interest charge on such bonds, and in addition thereto, such an amount as a sinking fund which shall, in the course of events and ultimately, amount to a sufficient sum to redeem said bonds."

Nor have I overlooked the further fact that the Supreme Court in the Argyle case, speaks of the bonds as a lien. Certainly, however, they are not a direct lien in the ordinary accepted sense of that term, as is true of mortgage bonds or bonds secured by trust deed. The bond holder would have no recourse to a court of equity for foreclosure in case of failure to pay. He may however have the right of mandamus to compel the proper officers to levy the tax. Such a step would probably be his only remedy. Indirectly however, the bonds being the obligation of the district, become a lien to the extent of each successive tax levy, and from the first constitute a possibility of lien to the extent of their amount within the limit of the valuation or benefits assessed. Such bonds should not be, and I believe are not, considered a direct lien in any such sense as a mortgage or other such lien upon the lands; they are of course, to the extent of the tax assessed first liens in the same general sense that all taxes general or special are first liens, and take precedence over mortgage

or other direct private liens whether prior or subsequent in point of time.

I want to say just a few words now on the question of compliance with the law, particularly from the standpoint of the salability of the bonds. After the larger questions of location and value of the lands, feasibility of the proposed installation, and other such matters as determine the question of whether bonds of the district would in any event be a safe investment are disposed of, the bond buyer next insists that he be furnished a transcript of proceedings leading up to the issue and sale of the bonds which will show the bonds to be the legally issued and outstanding obligation of the district. The validity of the bond issue necessarily depends upon a strict and I may say, almost technical compliance with the provisions of law leading to the issue.

It goes without saying that too much care cannot be given to the question of proper engineering. Without that it would be folly to undertake the installation of any drainage system—likewise it is of utmost importance that competent legal supervision be had, and it is also most important, (and let me emphasize this point) that an exact record be made of every step or proceeding had or taken.

Whether it is the inclination of officers of drainage district to consider the matter of legal supervision and advice as of no particular importance and consequently as not of much value, or whether the supervision and advice usually obtainable is of the cheap variety, I do not know, but apparently it is one or the other. My suggestion is however, (if I may be permitted to say a word in behalf of my fraternity) that it is usually pays in the end to pay the price for competent legal service.

Boards of Supervisors should also see to it that the clerical work is promptly and efficiently done.

Why, only a few months ago I had occasion to help in the preparation of a transcript of proceedings for the sale of bonds, and found that the minutes of the meeting of the Board of Supervisors had not been recorded for a period of two years. Failure to keep proper records is one of the chief vices of such organizations. I also had occasion, not long since, to be associated with another lawyer in the matter of supervising the organization and management of a district up to the sale of the bonds, and when I came to make up the transcript of proceedings, much to my surprise, papers that I had prepared with scrupulous care and forwarded to the proper office or officers with explicit instructions were missing, and the records contained only part of the proceedings actually taken. I remarked then that I would never undertake such work again unless the compensation was sufficient to justify me in seeing that every affidavit or other paper was properly executed, recorded and filed, and the tack in every posted notice driven straight.

Too much emphasis cannot be placed upon the necessity for strict compliance with the provisions of the act, and careful, exact recording of every step in the proceedings. I am well aware that the law contains a provision to the effect that errors and omissions not affecting the substantial rights of the parties shall not invalidate the proceedings, but when the attorney making the examination looks the transcript over and discovers errors or omissions, many times the question of whether they are errors reaching the jurisdiction or affecting the substantial rights of the parties is one of fact, and he will immediately insist upon validation proceedings at more expense and delay.

Good engineering, competent legal advice and service, and a full,

true and correct record of every act and proceeding are the requisites for the ready sale of district bonds. I thank you. (Applause).

MR. J. M. FORRISTALL (of Ogden): I wanted to know, if, in his opinion, under the present law as it now stands, should a drainage district strictly follow the conditions of that law, would there be a fairly good sale for the bonds or would it be necessary to so amend the law in regard to mandamus proceedings in case of failure of payment.

MR. CHENEY: No, I think the questions of engineering and feasibility and location, and all those questions, being decided favorably, if the present law is followed strictly, there is a ready sale for these drainage bonds. But I do say that I believe it will be necessary to amend the law to cut down the period of redemption.

MR. HAWKINS: Mr. Chairman, I am compelled to leave, but I have one question I would like to ask. The gentleman referred to the assessment roll. There might be a mistake made in the judgment of the supervisors as to the amount of benefit that may be derived in the construction of that work. Is it possible that the assessment roll may be changed after it has once been established?

MR. CHENEY: As I understand it, under the present law, after the benefit assessment roll has been made up and closed there is no provision for changing it, unless there should be some fraud or something of that sort, in which event there might be some opportunity of reaching the situation you suggest.

MR. HART: I think we have listened with a great deal of interest to the paper just read. The suggestion has been made that we declare a recess for a few minutes. But you must promise, before I declare this recess, that you will not leave, because we have been saving a feast for you in the next talk by Mr. Adney. If you will make that promise now, I will declare a recess for five minutes, during which time those of you who have not yet signed the register or become members of this organization, and care to, may come to this desk and do so.

(Following five minutes recess, MR. HART resumes):

The problems of the drainage district do not stop with the organization, neither do they stop with the completion of the district. Many of the problems that confront the districts come along later. There have been organized in the State twenty-five drainage districts, and many of these are well under way; four of them have been completed. Many problems have arisen to confront these various districts. We thought it was well to look forward, as well as to examine the present conditions, and to look backward over the trail which we have taken. So it seemed wise to invite here a supervisor of one of the districts which has completed its construction work and is now facing the prob-

lems of the future. The largest of the districts so far completed is the Corinne District at the north end of the Lake, in Box Elder County, of which district Mr. C. G. Adney, state representative, is treasurer. Many of the problems have had to do with his office, and he has kindly consented to come here today and tell us about the problems that confront the drainage districts. I think most of the problems, from his standpoint, are future problems. I take great pleasure in introducing to you Representative C. G. Adney, of Corinne. (Applause).

PROBLEMS WHICH CONFRONT DRAINAGE DISTRICTS

By MR. C. G. ADNEY

Mr. Chairman and Fellow Members of the Congress:—It is a pleasure to be with you today. I regret, however, that I have not been able to be with the Congress from the first for I know I have missed many instructive papers and addresses. I sincerely hope that the press will publish them in order that I and others who have been unable to be here may have the benefit of the proceedings of this Congress. From the many drainage problems which have been discussed since I came in, I think that all of you probably feel that if there are any other troubles which have not yet been mentioned that you sincerely wish they may remain quietly sleeping and undisturbed.

Mr. Anderson, our friend from the south, warns you that it is a very troublesome matter to organize a drainage district. I sincerely believe that if there is anyone who thrives on trouble, he would feel he had reached his first heaven when he tackled the organization and maintenance of a drainage district. I feel confident that no other district in the State has had as many troubles as has the Corinne Drainage District, of which I have been one of the supervisors. The problems are not only those of personal ability to organize, maintain and hold men together, but they get into such a vast and varied ramification of subjects that certainly no one person can hope to be big enough to compass successfully all the needs of a drainage supervisor.

When I was advised by the president of the congress that I was invited to tell some of my troubles here, I rather thought, from the nature of the topic assigned to me that I was expected to prophesy future troubles or predict things that would happen or might happen, and I felt that while I was not a prophet I could perhaps better all that bill than I could to point out remedies for evils that now exist.

The organization of a district, it seems to me, is still cumbersome as provided for in our law. The statutes as Attorney Cheney has observed, seem to fill, in the main, legal requirements and subserve our needs in a general way, but certainly they are burdensome and cumbersome and difficult of interpretation. There is room for a great deal

of improvement. It seems to me that one of the problems for the future is for the attorneys of the several districts to get together, match their experiences, and perhaps organize from members of the district a legislative committee, who shall look after the drafting of laws, the addition of new features and remedying of defects and cumbersome features of the old law.

The organization having been once completed, it seems to me that one of the problems is not yet solved in the minds of the people. While I have pronounced ideas on the subject,—and I think my ideas agree with the majority of those who have been instrumental in drafting the law as it now stands—the public remains yet to be convinced that the basis of assessment against their land should be purely that of benefits. The majority of the members of the district seem to feel that the matter of cost, as apportioned out to their particular tracts, or some particular subdivision of the district, should be taken into consideration when benefits are assessed to their land. For instance, if one isolated portion of the district is served by a very short outlet, and another portion, perhaps adjacent thereto, is served by a very long and expensive outlet, the men of that first section feel that the cost of construction should be taken into consideration in that case when benefits are assessed against their land. Just how this may be worked out, I do not know. I do know that it is very difficult for a supervisor to ignore the demands of the members of the district on that one particular subject..

Then, the lands in the district, in many cases, and perhaps in all cases, are only partly provided with water rights, and the man with the dry area, even though it is susceptible of irrigation, but he is not provided with a water right, complains as to his taxation, as to his benefits. He says, "I have no water right, and I am not benefited at all." Perhaps he contemplated purchasing a water right. Then, too, the land that is perhaps fifty per cent bad, as compared with that which is 100 per cent bad—if I might use that as a mere basis of comparison—shall we assess them as of equal benefits? Problems of this kind, it seems to me, are very knotty and are yet to be satisfactorily solved. In our district there were men who believed very strongly that the very fact that a tract of land lay within the drainage district, even though it did not need to be drained, should be assessed some nominal benefits because it lay within the district and the improvement of the lands, by virtue of the operation of the district, was going to work out a benefit to that particular tract.

I think perhaps one of the most important problems of the future is the utilization of the drainage water after it has been discharged from the land,—the bringing of that water upon new lands or upon lands within the district, by the process of pumps, reservoirs, and so forth, or a combination of these things, or by careful arrangement of the discharge outlets in order to make this water available to other lands. We get quite large volumes of water out of these large mains, and certainly it ought not to be permitted to go to waste after the mineral salts have been reduced to a point where it may be safely used for irrigation purposes.

One problem which has occurred to me is that of the proper period for irrigation, and the duration of that period. Shall we irrigate the maximum, in the spring of the year, in the middle of the season, or in the latter part of the season? How long shall we maintain this maximum on heavily mineralized lands? We have been taught for a number of years by agricultural chemists that the action of frost and air combined during the winter season, makes soluble and available for crops previously insoluble materials in the soil. If this be true, then we would expect the

previously insoluble fertility of the soil to become soluble and be washed out in largest quantity in the early part of the season. Certain it is that we wash out vast quantities of soluble salts that are desirable at the same time that we are washing out the undesirable mineral salts. In our district last year we made some analyses from time to time. We did not keep a very accurate record of these things and I do not wish to submit my statements as finally conclusive in the matter. There was flowing from one fifteen-inch main in our district potash to the value of fifty cents a minute. I know of no way of preventing that potash from escaping until we shall have reduced the amount of undesirable mineral. One of our residents, now a resident of Idaho, Mr. J. C. Wheelon, performed considerable experimental work along this line, and he issued a warning to men of this state calling attention to the danger of over washing the land after it is tile drained. We found that our analyses showed a much higher percentage of potash in the early spring than it did later in the season. I think this is a problem that ought to be investigated very thoroughly and very carefully,—a problem probably for the Agricultural Experiment Station to work out. The majority of us farmers are not competent to solve the problem.

Another problem which has confronted us has been already mentioned, and I think it is rather a knotty problem. Our supervisors are rather inclined to view it a little differently than those from the South view it. I refer to the washing in of dirt, through carelessness in irrigation, or other processes. Shall we make repairs in case of carelessness, where it is clearly the carelessness of the operator, the owner of the land or his tenant? Shall we make those repairs at the expense of the general fund or shall we be permitted a special levy for that repair and tax it up to the tract on which the damage occurred? It is the opinion of our supervisors that that ought to be cared for by a special levy, that the general fund ought not to be taxed with the carelessness of a particular individual, if it is clearly a case of carelessness. We realize that it becomes a matter of trying and fining a man without "a day in court," and we have tried to cover the difficulty with by-laws and rules of the district.

The district having been organized, the kind of tile, size of tile, the depth of the tile, the spacing, and so forth, are engineering problems, but they are problems which have not as yet been very well solved or established. We can go into most any other line of engineering and seek information and we find exhaustive tabulation; tables which will give us at once very closely the information we desire. In tile draining such is not the case. Very little has been compiled, there is very little real authority today on this subject of tile drainage. It remains a matter largely of individual engineering experience, and the experience is yet such that it seems that most of the engineers are not prepared to write it down in the form of a text or reference book.

The matter of the carrying capacity of tile, it is true, has been worked out pretty well by the aid of Kutter's formula, plus some other things, but the varying degrees of roughness—whether it is smooth cement tile or whether it is one of many degrees of rough surface cement tile—all become problems. These are purely engineering problems, but we would like to have them solved and solved so that even an unskilled man may look at a table and have some idea regarding the size of the tile, the grade at which it is to be laid, the quantity of water that is to be discharged, and the final carrying capacity. We would like to have worked out for us some method, some means of ascertaining approximately what the volume of water is, which is to be extracted from the soil. So far it is merely a matter of guess. Also we should know whether or not we should

lay our tile of such size to take care of the maximum flow, or whether we should lay our tile of a considerably smaller size than will take care of the maximum flow, thereby extending the period of saturation, or approximate saturation of the soil. These are problems that I think are yet unsolved, and they are of vast importance, because they affect the cost of the district, they affect the working of the district after it is completed.

Then, too, there comes a problem of the depth at which the tile should be laid. How deep ought we to go? There must be a critical point where the cost of deep cutting will balance the benefits to be derived therefrom.

Then comes the matter of spacing. In our district the average spacing is about four hundred feet parallel lines. If we were asked why we spaced it thus we would have a great deal of difficulty in telling just why. We guessed at it and we passed it to other men who had guessed at it, and we thought probably that it would do. I hope it will. One man from the Bureau of Soils from Washington looked the matter over and said: "Undoubtedly you have constructed a fool proof proposition, because it is close enough that it must work; it must take care of your lands." That was rather satisfactory, but if those things could be worked out to a standard, it certainly would be for the benefit of the district organized.

In further reference to the benefit assessments we must all agree that when the supervisors shall have levied every benefit against the various tracts of land, against the various parcels of land, that they are likely to be wrong. Not only that, with the present method now in vogue of preliminary investigation as a basis for the organization of the district, there remains some doubt as to the real acreage that is to be benefited by full benefit, or fifty per cent benefit, or twenty-five per cent benefit, or whatever it may be. In our district we just assumed a benefit that was to be the standard with the majority of the tracts in the district,—the maximum benefit, we will say,—and then we worked along down to various percentages of benefit as compared with the maximum. It seems to me that our statutes probably ought to be amended so that after the benefits have been assessed and after the district has been completed, a real assessment may be levied according to the actual benefits and actual acreage as nearly as these may be arrived at.

We did make some revisions, although the statute did not provide for them. We took it upon ourselves, as supervisors, to revise many of these benefit assessments; and we did that, in the face of protest of the attorney for the bond buyer. It is a significant fact that regardless of your opinion, or my opinion, or the opinion of any supervisor, or any attorney in the matter, the attorney for the bond buyer has the last guess, and if it is his opinion that you have performed insufficiently, it is very vital to you, whether you think it is right or whether you think it is wrong, because, if he reports adversely, his client is not going to buy the bonds, and upon the sale of the bonds rests absolutely the success of the district.

In our case it was the opinion of the attorney for the bond buyers that we should have a case in the supreme court to test the statute before they would risk any money on the bonds. As the statute is amended from time to time, another attorney may come along and ask for another test case in the supreme court. We hope that such may not be the case, we hope that the amendments may be such that it will not be called for.

The previous speaker referred to the matter of the delinquent assessment running four years before a tax sale could issue. That may be too long; it may be that it should be cut down to two years. It is a matter that ought to be discussed very carefully. Certainly if it would remove

some of the difficulties of selling bonds, it probably would be wise to have the statute amended in that particular.

There is another feature which I think is a difficult problem and which ought to be solved. It is a matter that has been discussed, it has been thrashed over, it is not a new one. I refer to the appurtenancy of water to the land. I am not an advocate of appurtenancy of water to the land throughout the state particularly, but I do think there ought to be some means whereby the water may become absolutely appurtenant to a tract of land in the drainage district during the life of the bond. One of the first things the bond buyer enquires into is the permanency of the water right. You gentlemen are well aware that in this State a water right which is represented by a certificate of stock in a corporation is held to be personal property, and that certificate may be taken to a bank and mortgaged, or it may be sold and the water separated from the land. While this might not become a serious handicap to the bond, it is a bugaboo at least that is questioned by bond purchasers. It would be a very material aid in the selling of the bonds and in establishing a stability in the matter, if the water right could be made appurtenant to the land.

I think there are many other problems, many other difficulties, but I believe I will leave the balance of them for you to dig out. (Applause.)

DR. FORTIER: Mr. Chairman, I would like to ask Mr. Adney to describe briefly the process of leaching out the soil that was more or less impregnated with common salts and other minerals.

MR. ADNEY: I do not know that I fully got your question, Doctor,—as to the results we are getting?

DR. FORTIER: Well, yes; but I was thinking more particularly, Mr. Adney, of the methods that you employ. Our division is very much interested in that and I had to do something of that kind in Fresno, and I am here for information.

MR. ADNEY: In reply to Dr. Fortier's question in regard to the method employed in our district as to the leaching out of soil, I would like to say that the vast majority of the acreage in our district had not gone entirely bad. There was very little of it that would not produce some vestige of a crop. Only small areas, perhaps forty acre tracts, in isolated places were so bad that almost no vegetation would grow upon them. Our first rule has been to thoroughly level the ground, not literally level it, but surface it so that the water would flow over every portion of the land. With us the redemption has been so speedy that we have not had to pursue a whole season of washing. There is no tract in our district that has not responded speedily enough that we could not grow a crop following one or two or three washings.

One of the worst forties in our district was irrigated three times during the summer season following its tiling. The next spring that tract was planted,—twenty acres to beets and twenty acres to sprig-planted wheat. The wheat yielded eighteen bushels to the acre, and the beets yielded eleven tons to the acre. We have other tracts that were not quite as bad as that in our district which, the first year, after having had two washings, have gone as high as fifteen tons of beets to the acre. I mention beets particularly because that is a standard product.

In speaking of these tracts, I am reminded of one feature of the law which I think presents a little problem that ought perhaps to be rectified. We are expected to make this benefit assessment upon each individual parcel or piece, without being advised as to what is the minimum or maximum size of that tract. A parcel of land might be eighty acres, it might be one hundred and sixty acres, it might be forty acres, or it might

be twenty acres; and it seems to me probably there ought to be some statutory enactment defining parcel.

MR. M. A. ABBOTT: I understood you to say that in spite of the bond buyer's attorney that you, after the benefits had been assessed and had been equalized did then go over these assessments and make some revisions. Tell us something about that, will you? We have those problems and we do not know what we are up against.

MR. ADNEY: I would not like to have any one follow in our footsteps on the theory it was right or correct, because I think we perhaps took the action we did without legal warrant; I think it might be subject to criticism and perhaps more than that,—I do not know. But we felt that it was justice to the individual holder of the land. In the cases where we revised, the revision generally showed a small decrease. There were a few tracts that were revised upwards, and in those cases it was done with the consent of the owner. Whenever we ascertained that there was a greater acreage than we had assessed a maximum benefit to, or that would come within the maximum benefit, as contemplated under our construction, we had an understanding with the owner and raised it with his consent. In those cases I think we would have no trouble, but we did revise a number of pieces in our district both up and down.

Mr. Hart asks if that varies our benefit. I would say that it did slightly, but it so happened that the upward revisions about balanced the ones that were revised downwards, and therefore, it left the total footing with but little change.

MR. ABBOTT: The point is that you must certify the benefit is so much, and you might get into all kinds of trouble if you changed that.

MR. ADNEY: I think we changed that a little, and we may get into trouble, I do not know; but we took that responsibility. I think it only points to the fact that there ought to be legislation covering that particular feature.

MR. ABBOTT: There is another matter I would like some information upon. We have gone thru the process of equalization and have commenced construction. In our district we have been compelled to use a great deal of open canal work and in some places those canals are very large; in fact, one of them is eight feet deep and twenty feet wide on the bottom. Of course, the banks occupy a considerable portion of the land. We have endeavored, in constructing those open canals, to divide the land occupied by our canal between two land holders, constructing, as nearly as we could along the lines of 40's or local subdivisions and also in some places field roads or county roads. Now, then, we recognize the fact that we have occupied some of that farmer's land for a public benefit and at the same time he is assessed upon that land that we are occupying permanently. He is assessed benefits, so that he will be forever compelled to pay taxes upon that land which we are occupying, even for the benefits of construction, the interest and maintenance taxes thereafter. We do not know of any way or any method by which we can give that man the relief to which he is clearly entitled. That is one of our problems. Have you had any experience with that? We would like to have some information along that line.

MR. ADNEY: The statute provides and contemplates a damage assessment, and it is at all times open to supervisors to make a damage assessment and award to the individual whatever damage has been sustained. It seems to me that you could solve your problem by making use of that feature of the statutes and assess whatever damages has been sustained by that particular land.

MR. ABBOTT: We have thought of those things, but in our district

we have about sixty-three miles of that sort of construction and we figured that if we opened up that question of damages possibly we would never get out of trouble and that a great portion of our construction fund would be absorbed in paying damages; therefore we have avoided it. (Laughter.) We do not know how to remedy that thing and do justice to that particular land holder, and we do not want to enter into that question of damages.

MR. ADNEY: I think the gentleman is in the position of a good many supervisors,—and I confess to having pursued the same policy in our district. On the portion covered by spoiled land, which would forever be taken out of any beneficial use to the owner, we put that within what we termed nominal benefits. We assessed his acreage that remained open to his usage at the maximum benefit, for instance, and the area within the spoiled banks we assessed at a nominal benefit.

MR. ABBOTT: We were estopped from that by the fact that when those benefits were assessed, we were not certain, even after the design had been made, where those open canals would be finally laid; and as a matter of fact, we did in a very great number of cases, change the line of our open canals, so that after the assessment had been made and the benefits had been assessed and equalized we found ourselves in that predicament that we were then unable to make the equalization.

Another problem has confronted us, and I wonder if you have had a similar experience. In our district we have found that the advance of percolating water was great, was very rapid. We went over the classification of the land twice very carefully but we have found between the time of the classification and the assessment of benefits and the time of actual construction that some of those lands have been water-logged, and those lands are enjoying the higher classification or the lower rate of assessed benefits. In that way it has been unequal and unfair to some of the other tax payers and farmers. We do not know how to remedy that.

MR. ADNEY: I think that only emphasizes the need of an amendment to our law. I think it can only be reached in that way. The law should be revised to take care of that situation. I can see no other way.

MR. ABBOTT: I think it should, in justice.

(Following President Widtsoe).

MR. ADNEY: Mr. President, I would like to say just one word with reference to the matter of the Department which Dr. Fortier represents. From his Department and from the Agricultural Colleges of our State and a few of the other Western States comes practically everything we have upon which to base our work of drainage. In fact Dr. Fortier is the father of reclamation by drainage. I remember years ago, just how many years, I do not remember, but a good many years ago, of his pioneering work in and around Fresno, California, and now California is devoting millions of dollars to drainage reclamation.

I hope every man here will exert himself to the utmost in an effort to see that Dr. Fortier is amply provided with funds. I am confident that if Dr. Fortier is amply provided the problems mentioned in this paper will soon have been solved for us. (Applause).

MR. HART: Things are never so bad but what they might be worse. I want to say for Mr. Adney's special benefit in respect to his first statement, that Utah has the most simple law

in the West; so he might have gone into some of the other states where they are worse.

There was intimation a little while ago that some of you desired to ask some questions. I think now is a good time to ask those questions. Are there any questions?

MR. ASHBY: Mr. Chairman, in creating a drainage district, who is going to have the right to use that water,—the irrigation company, the men below, or the men who have created the drainage district?

CHAIRMAN HART: If you were here this morning, you had that question answered for you.

MR. ASHBY: I was here, Mr. Chairman.

MR. HART: That is one of the problems that will have to be worked out now in the light of the recent decision of the Supreme Court.

MR. ANDERSON: I would like to ask one question in reference to the collection of taxes. Is there any way a man can pay his taxes and say what it is to be applied on? Suppose a man's drainage taxes amounted to fifty dollars and his other taxes amounted to a similar sum; can he go to the county treasurer and pay fifty dollars and say, "I do not want to pay the drainage taxes; let that stand?" Can he do that? Can he pay, say fifty percent, of his taxes in that manner?

CHAIRMAN HART: I think I had better turn that question over to Mr. Cheney. I do not know whether he will charge anything for his advice or not.

MR. ANDERSON: He generally does. (Laughter).

CHAIRMAN HART: I will tell you of an experience I have had. The Attorney General of the State has ruled that you cannot deny a man the right to pay his other taxes. In Millard County the County Treasurer is actually accepting state, county and school taxes and not accepting the drainage taxes, with the result that there have been some delinquencies along that line. I think it can be done legally.

Are there any other questions? If not, I will, on behalf of the Congress, thank very heartily the speakers who have appeared before us this afternoon and who have gone into these matters, and then I will turn the Chair over to Dr. Widtsoe for other matters in connection with your business this afternoon.

Discussion (following Mr. Adney).

DR. FORTIER: Mr. Chairman, I would like to ask Mr. Adney to describe briefly the process of leaching out the soil that was more or less impregnated with common salts and other minerals.

MR. ADNEY: I do not know that I fully got your question, Doctor,—as to the results we are getting?

DR. FORTIER: Well, yes; but I was thinking more particularly, Mr. Adney, of the methods that you employ. Our division is very much interested in that. I had to do something of that kind in Fresno, and I am desirous of securing information.

DR. FORTIER (following Chairman Hart).

Mr. Chairman, I just wanted to say a few words. I, for one, felt pretty guilty, when Mr. Adney was citing case after case, where more information was needed regarding drainage systems. He went on to state that we are uncertain, we are guessing as to whether an open ditch or a drain tile should be laid; we are uncertain as to the depth of the ditch or tile, we do not know yet how far apart they should be, we are uncertain as to the size; and a number of other questions that are awaiting investigation and solution.

I think that our Division, which is in charge of irrigation and drainage west of the Missouri River, might be considered responsible in a measure for that situation. You may think that we have been neglecting our duties in letting you guess at all of these important questions which bear so heavily on the future development of this western country. I want to say that it is not our fault. During the war, when we found that we could raise more crops by drainage than in any other way, it was useless, gentlemen, to reach out into the head waters of the streams and bring that water down to irrigate sage brush land. That would take years and years. But here and there were tracts of land,—ten thousand, thirty thousand, or even forty thousand acres,—which might be drained and reclaimed and brought back to its original fertility in a year or so; and so there has been a tremendous pressure on our Bureau to help reclaim these areas. No one knows more about this proposition than does Mr. Hart, because he has been traveling from one state to the other, helping them organize, helping them get started off on the right foot. So we have been compelled to devote our time and energies to

other problems. It is up to you, gentlemen. If you think it is an important work, all you have to do is to induce Congress to give us more money. It is not for us to ask for more money, but we are helpless without it. The Agricultural Committee of Congress cut down our appropriation during the war for the alleged reason that labor was so high and expenses were climbing at such a rate that drainage was not feasible. As a matter of fact, everyone will tell you that there has been far more land reclaimed during the past two or three years than in double or treble that period in previous times. And we are facing the same problem today.

Before the war I had started out to prepare a publication on the benefits of drainage districts. I was going to ask Mr. Adney and Mr. Hart here in Utah to contribute their portion for that subject, and so with men in Washington and Oregon and Arizona, taking in all of the western states. I thought if I could describe the benefits that had accrued as a result of our connection with some twenty-five drainage districts in the west, it might probably be of some value; but only a beginning has been made and I do not know when that publication will be completed.

RESOLUTIONS

**PASSED BY THE UTAH IRRIGATION AND DRAINAGE CONGRESS
IN ITS THIRD ANNUAL SESSION, OGDEN, UTAH,
JANUARY 29th-30th, 1920.**

1—Whereas, the officers of this Congress have spent much time, and effort in arranging the excellent programme here presented, and whereas Judge T. D. Johnson has courteously extended the privilege of holding these meetings in this court room, and whereas Mayor Francis has extended to the members of this Congress a very generous welcome to this city, and whereas the newspapers of Ogden have given much space to favorable press notices and whereas, Dr. Samuel Fortier and Prof. Frank Adams have made special effort in coming from California to attend this Congress, and have thus manifested their intense interest in the irrigation problems of this state,

Now, therefore, be it resolved that the hearty thanks and appreciation of this Congress be voted for these many courtesies and generous aid contributing to its success.

2—Whereas, it is believed that the work of the Water Storage Association is invaluable in the solution of the irrigation problems in those counties where work has been done,

Now, therefore, be it resolved that the Utah Irrigation and Drainage Congress expresses itself in favor of adequate state legislation which will provide funds for the continuation of this investigation work through out the state.

3—Whereas, the present methods of distribution and use of water by the numerous irrigation companies is in many cases inefficient and wasteful,

It is therefore resolved that the Utah Irrigation and Drainage Congress individually and as a body pledge itself and its members to assist in a more efficient utilization of the streams, thru the unification and reorganization of these irrigation companies and the centralization of management made possible by the formation of irrigation districts.

4—Whereas, the Utah Agricultural College is supported by funds from the State and has assigned to it the duty of teaching and investigating various phases of irrigation and drainage, and in such capacity is in a position to be of great assistance to the agricultural interests of the State, and whereas we believe every available agency should be used, therefore be it resolved:

(1) That we favor a continuation of the co-operative relations existing between the Agricultural Experiment Station and the Division of Irrigation of the United States Department of Agriculture.

(2) That we favor the co-operation between local agencies such as canal companies and such State and Federal agencies as are available in solving local problems of organization in which such co-operation can be helpful.

(3) That we commend the Agricultural College in its efforts to reach the irrigator thru its various extension activities, and thru such instruction as outlined in its course for watermasters, and we urge canal companies to take advantage of this instruction.

(4) That we recognize the importance of having available a body of exact information on the water needs of crops produced on different soils and we therefore favor continued support on the part of the State for experimental work in irrigation and drainage.

5—Whereas, the proper distribution of water in an irrigation system

is of greatest importance to the success of the project and involves duties of a scientific and technical nature,

It is therefore resolved that the Utah Irrigation and Drainage Congress pledge itself in favor of employing trained watermasters and competent engineers to perform these duties.

6—Whereas, the jurisdiction of the State over the streams is now limited by the state boundary lines, and whereas this condition also exists in our adjoining states and tends to prevent the most efficient use of interstate streams in the vicinity of these state boundaries,

Now, therefore, be it resolved that the U. I. D. C. favors appropriate action by the proper state officials to bring about an understanding with our sister states that will permit the most beneficial use of all streams regardless of state boundary lines.

7—Whereas, the work of the Division of Irrigation of the United States Department of Agriculture and the Water Resource Branch of the United States Geological Survey are recognized as being of the greatest importance to the welfare of the irrigation interests of the West, and whereas the appropriations available for this work are inadequate to conduct the work as it should be conducted, therefore be it resolved that this Congress request the Congress of the United States to provide more adequate support to these branches of the government service.

OFFICERS FOR 1920

E. G. Peterson, Utah Agricultural College,	President
H. S. Kleinschmidt, Construction Engineer, S. L. C.	1st Vice President
Hon. D. D. McKay, Huntsville, Utah,	2nd Vice President
Hon. H. P. Ipson, State Land Bank, Beaver,	3rd Vice President
O. W. Israelsen, Utah Agricultural College,	Secretary-Treasurer

DIRECTORS—JUDICIAL DISTRICTS

1st—C. G. Adney,	Corinne
2nd—J. L. Robson,	Plain City
3rd—C. J. Ullrich,	Salt Lake City
4th—Karl Keeler,	Payson
5th—H. E. Maxfield,	Delta
6th—R. D. Young,	Richfield
7th—J. M. Knighton,	Gunnison

CONGRESSIONAL DISTRICTS

1—E. P. Ellison,	Layton
2nd—W. J. Mitchell,	Salt Lake City

STATE AT LARGE

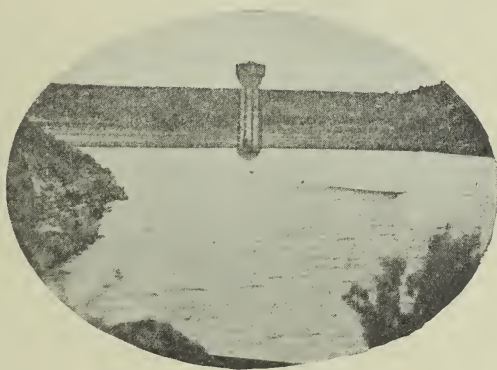
1st—J. R. Murdock,	Heber
2nd—Ephriam Bergeson,	Logan

TABLE OF CONTENTS

Inception of the Congress.....	9
Purpose	9
Policies	10
Opening Meeting	10
Report Organization Committee.....	12
Officers For The First Year.....	13
Important Drainage Engineering and Soil Problems by R. A. Hart.....	14
Meetings in Salt Lake City, 1917.....	20
Constitution of The Congress.....	21
By-laws	22
Drainage of Irrigated Farm Lands, by C. F. Brown.....	25
Members of The Congress.....	33
Second Annual Meeting.....	35
What Can Utah Irrigators Contribute to the World's Agricultural Progress, by Dr. John A. Widtsoe.....	38
The Growth of Fundamental Doctrines Upon Which Western Water Rights Rest, With Special Reference to Water Rights in Utah, by Dr. George Thomas.....	40
Resolutions of The Congress, 1918.....	47
Officers for the Second Year.....	49

THIRD ANNUAL MEETINGS

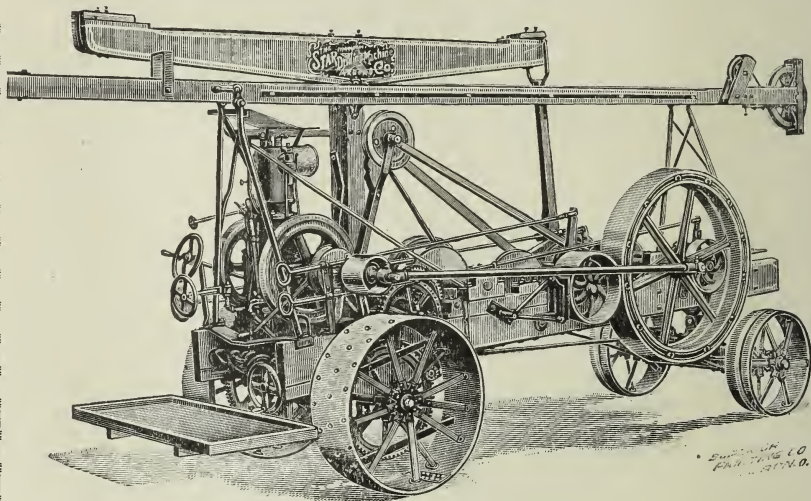
Address of Welcome, Mayor Frank Francis.....	51
Irrigation Reconstruction in Weber County, Utah, Dr. Samuel Fortier.....	52
Summary of the Present Status of Centralization in the Manage- ment of Utah Irrigation Systems, Mr. L. M. Winsor.....	62
Irrigation Districts as a Factor in California Agriculture; Their Use as an Agency in Irrigation Reorganization, Professor Frank Adams	66
Address, Mr. Caleb Tanner.....	74
A Map of Utah's Future Irrigation Expansion—President's Annual Address, Dr. John A. Widtsoe.....	80
Illustrated Lecture, Dr. Samuel Fortier.....	86
Interpretation of Laws Controlling the Use of Ground Water, with Special Reference to Water Developed by Con- struction of Drainage Systems, Judge S. R. Thurman.....	88
Organization of Drainage Districts, Joseph P. Welch.....	101
Administration of Drainage Districts, Oscar A. Anderson.....	109
The Drainage District Law, A. M. Cheney.....	114
Problems Which Confront Drainage Districts, C. G. Adney.....	121
Resolutions, Adopted by the Congress.....	131



Store Utah's Flood Waters

STAR DRILLING MACHINES

HAVE PLAYED AN IMPORTANT PART
IN THE IRRIGATION PROJECTS
OF THIS AND OTHER COUNTRIES



THE STAR MACHINE IS MADE IN
MANY SIZES—A SIZE FOR EVERY PURPOSE

TRACTION or NON-TRACTION TYPE
STEAM or GASOLINE ENGINE POWER

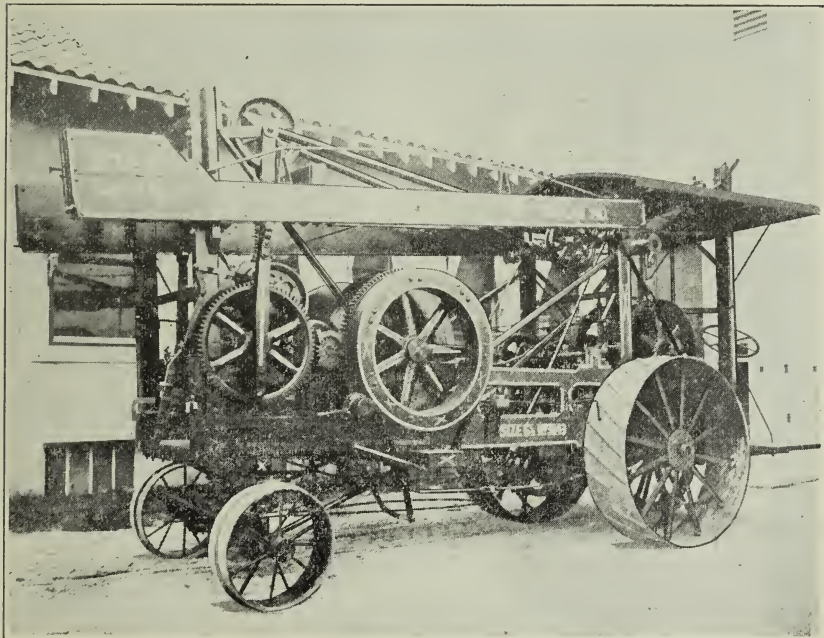
THE STAR WILL DRILL WELLS
ANY DEPTH—ANY DIAMETER

WRITE FOR CATALOG
THE STAR DRILLING MACHINE CO.
AKRON, OHIO

Branches
Chanute, Kan. Portland, Ore. Long Beach, Cal.

FOR YEARS

In every part of the world THE KEYSTONE DRILL has been demonstrating its superiority—Its adaptability, to the exacting needs of prospectors and operators everywhere.



BUILT TO WEAR—BUILT TO LAST

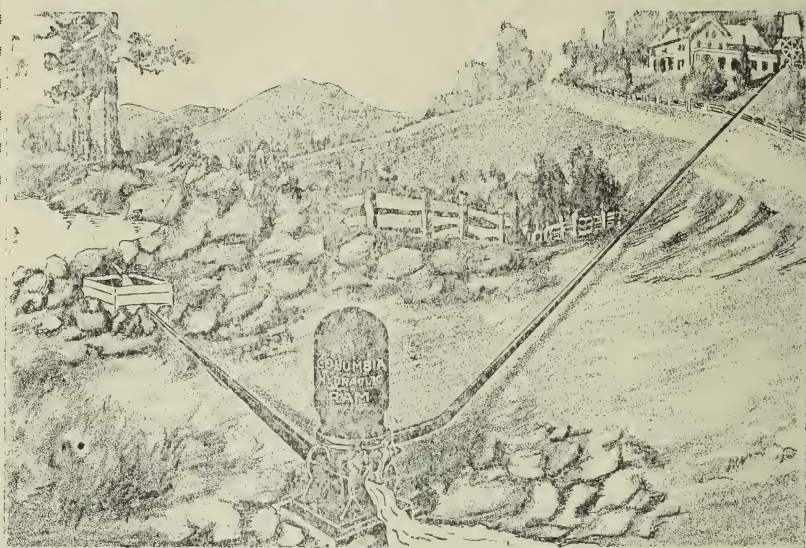
Built for all-around general purpose drilling and prospecting. They give universal satisfaction wherever tried and used.

KEYSTONE DRILLER CO.

BEAVER FALLS - - PENNSYLVANIA
Southwest Branch Factory, Joplin, Mo.

IRRIGATE

the lands above your ditch or stream with a
Columbia Hydraulic Ram



Three feet of fall from the main ditch to any lateral, or the same fall in any creek makes possible the use of our Ram. With the **COLUMBIA HYDRAULIC RAM** you can have the luxury and convenience of running water in your house, barn and farmyard.

Operates automatically, night and day, without expense and without attention. It makes the water do the work. All you need is a stream or flowing spring.

Send Us Today

the information requested on the coupon and we will send you a blue print showing the size of ram you will need and the quantity of water it will deliver.

FILL OUT This Coupon

Associated Engineering Corp.
902 Spalding Bldg., Portland, Oregon

Please send me full information regarding the Columbia Hydraulic Ram.

How many gallons of water per minute are available?

How far in vertical feet can ram be placed below intake?

This means vertical fall not the length of pipe.

How far in vertical feet must water be raised?

How many gallons are desired per day?

Name

Address

Western Problems Demand the Work of Western Men

Prepare Yourself in The

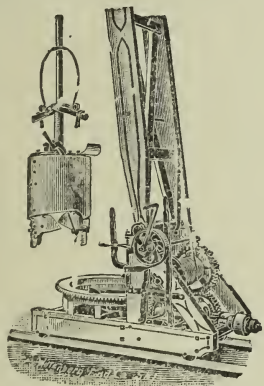
U. A. C. School of Agricultural Engineering

Special Attention Given to Irrigation and Drainage

Technical courses in Design of Irrigation and Drainage Systems, and in Irrigation Institutions for Agricultural Engineering Students. Practical Courses for Irrigation Farmers, Water Masters, and Correspondence Students.

For Further Information Write

The Department of Irrigation and Drainage
Utah Agricultural College
LOGAN, UTAH



Monitor Well Auger
Set Up For Work.

RECOMMENDED BY EXPERIENCE

Monitor well augers and Monarch rock drills have proven their worth for 37 years. It will pay you to investigate. They do their work well.

WELL MACHINERY OF ALL KINDS

We make well machinery of every kind and for every purpose, light or heavy work, deep or shallow wells. Tell us your needs.

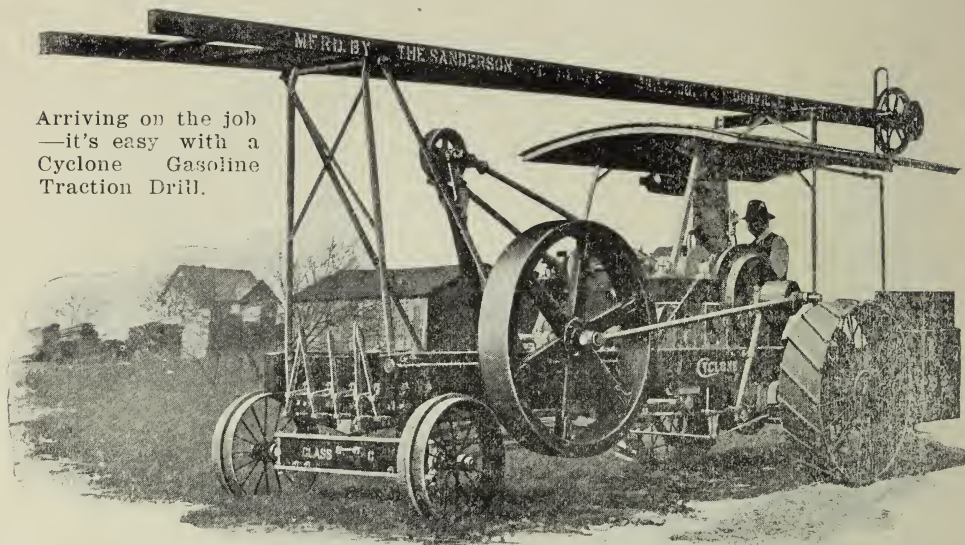
**WE HAVE MACHINES IN STOCK
AND CAN SHIP AT ONCE.
NO DELAY.**

Write for descriptive catalogue, prices and terms.

Gus Pech Foundry & Mnfg. Company

Le Mars, Iowa, U. S. A.

Arriving on the job
—it's easy with a
Cyclone Gasoline
Traction Drill.



IRRIGATION BY DRILLED WELLS

THERE are very few localities where an abundant water supply cannot be obtained by drilling wells. Once secured this supply is constant: droughts have little effect on it.

What is more important each land owner can have his own individual supply and need not be dependent on outside sources in times of emergency.

In the past few years, the improvements in well drilling and pumping machinery have brought down the cost of irrigating by drilled wells to a point where it is practical and economical proposition for individual use.

In the developing of irrigation by drilled wells, Cyclone Drills have played an important part. The machines are so designed that the drilling tools of several systems of well drilling can be handled to equal advantage, making it possible to cover the wide variety of underground formations found in many of the western states at a minimum expense.

Cyclone Drills represent the latest developments in well drilling practise. In addition, they have incorporated all modern mechanical improvements and labor saving devices making their operation a far-cry from that of the crude old-fashioned well boring outfit. If interested in drilled well irrigation or the possibilities of well drill contracting as business write for our general catalog A-73. This is a 160 page covering well drilling in detail and fully describing Cyclone Drills.

The Sanderson-Cyclone Drill Company

ORRVILLE, OHIO.

The World's Largest
Water Developers

Layne Patent
Line Shaft

Coupling connecting
pump head proper
with shaft and bearing
protecting and lubri-
cating casing

Shaft couplings

Patent shaft and
bearing protecting
and lubricating cas-
ing

Combination shaft
bearing and cou-
pling the shaft and
bearing protecting
and lubricating cas-
ing

Discharge pipe leading
to pump

Patent (Gensilis)
line shaft

Oil casing

Pump head and
shaft bearing

Patentized
bearing

Complete pump
bearing upper im-
peller and shaft
bearing, supported
bearing's speed

Section A-A

Layne & Bowler pumps have achieved leadership by reason of the service and satisfaction given to more than 6000 PUMP USERS

These Turbine cen'rifugal pumps
are being used for Irrigation,
Municipal and Mining Service.

Capacities 180 to 4500
Gallons per minute.
For 10 in. wells or larger
Request Folder No. 48.

Layne & Bowler

Corporation

900 Santa Fe Ave.
LOS ANGELES, CALIF.

**BEAN
PUMPS
FOR
WATER**
Lots of It.

**Bean Spray
Pump Co.**
San Jose, Cal

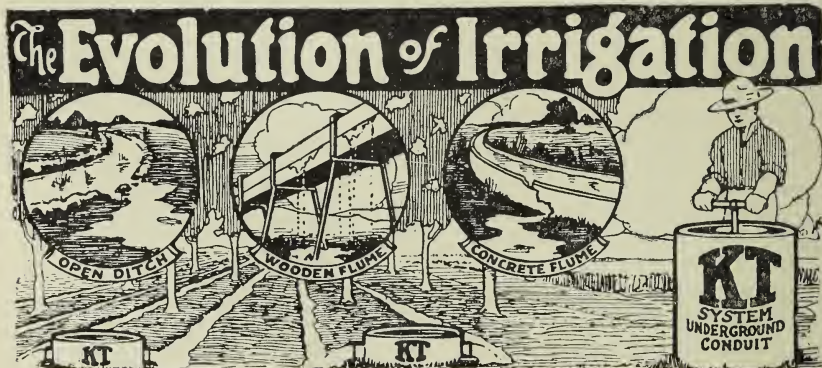
**Help Improve Irrigation
and Advance Drainage**

By Joining the

**Utah
Irrigation and Drainage
Congress**

Life Membership - - \$15.00
Annual Membership - - \$1.00

Send your check to the
Secretary-Treasurer



IRRIGATION APPLIANCES

**Conserve Land, Labor and Water and
Insure Maximum Crop Production**

MARTIN IRON WORKS, Los Angeles

Catalogs and Information on Request

JULIEN P. FRIEZ & SONS

MANUFACTURERS

ANEMOMETERS

PSYCHROMETERS

SUNSHINE RECORDERS

UNIVERSITY OF MARYLAND

JUN. 3 1921

WATER STAGE REGISTERS

RAIN GAGES & REGISTERS

EVAPORATION HOOK GAGES

BAROGRAPHS

THERMOGRAPHS

HYGROGRAPHS

WINDVANES AND OTHER

METEOROLOGICAL INSTRUMENTS

Material, Workmanship and Performance
Unexcelled.

Baltimore Street and
Central Avenue

BALTIMORE, MD.

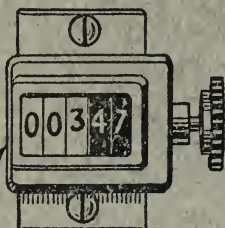


Experimental Irrigation, The Basis of Irrigation Science



3 0112 077581087

*Don't guess about your irrigation bills-**know***



The Lyman Irrigation Meter will tell you exactly how much water you have used.

It is on the job day and night and records the slightest rise or fall of the weir discharge.

The Lyman Meter does away with the guesswork of frequent measurements during the day and night.

Built for all sizes of Cipolletti and rectangular weirs. Can be attached to the weir in a few minutes by anyone and costs but \$28.50

Free pamphlet containing valuable tables on the measurement of irrigation water mailed on request. Write for a copy.

Lyman Water Register Company

411 PARKER STREET
West Berkeley, California

(1)

